U.S. Army Aeromedical Research Laboratory Annual Progress Report, FY 1984

(1 October 1983 - 30 September 1984)

Reported By:
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The Annual Progress Report gives the FY 84 personnel and funding strength of the U.S. Army Aeromedical Research Laboratory. It outlines the 11 scientific programs being pursued by the Laboratory. These programs are: Visual and auditory physiology; auditory effects of blast overpressure; noise hazards of combat vehicles; impact biodynamics of crashworthy aviation equipment and personnel armor; vibration hazards of combat vehicles; crew life support systems technology; sensory limitations and man/machine systems; biomedical aspects of crew workload, selection, and staffing; anthropometry and ergonomics: criteria for Army aviators; and antidote and antidote/agent effects on the visual system.

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Mission

Conducts research and development on health hazards of Army aviation, tactical combat vehicles, and selected weapons systems. Assesses the health hazards from noise, vibration, acceleration impact, and visual demands of such systems, and defines measures to offset hazards. Assesses stress and fatigue in personnel operating these systems and develops countermeasures. Assists in development of criteria upon which to base standards for entry and retention in Army aviation specialities. Assists other US Army Medical Research and Development Command (USAMRDC) laboratories and institutes in research on the bioeffects of laser systems, medical defense against chemical agents, impact of continuous operations on individual and crew performance, and development of means of patient evacuation. Assesses current life support equipment to identify causes of failure and devise improved design. Assists the combat developers and materiel developers of new Army aviation and tactical combat vehicle systems to recognize and eliminate health hazards as early as possible in the developmental cycle. Conducts collaborative research with other Department of Defense and other Federal agencies on medical research and development issues of common concern.

Introduction

Research goals are derived from a thorough review of threat information and ongoing doctrine development as portrayed in AirLand Battle 2000 concepts; further impetus is driven by the understanding of the recognized Army deficiencies contained in the Mission Area Analysis (MAA). The total research mission is in consonance with the priorities established by Headquarters, US Army Medical Research and Development Command (USAMRDC), Fort Detrick, Frederick, Maryland.

The United States Army Aeromedical Research Laboratory (USAARL) was established by Department of the Army General Order 39 on 1 July 1962, and was implemented by Office of The Surgeon General by General Order 42 on 4 October 1962 to accomplish research in support of the Army aviation community and airborne activities, and to provide a central aeromedical research and reference library for the Army aviation effort. Additional mission areas were added to the Laboratory in 1974. The Laboratory's further expanded mission now includes the assessment of the medical impact of advanced armored and artillery weapons systems and other nonmedical materiel. Major emphasis is placed upon the prevention of health hazards of emerging weapons systems and the enhancement of soldier performance. New research programs in medical chemical defense recently have been added.

USAARL is one of nine medical research laboratories of USAMRDC, Office of The Surgeon General, and is a tenant organization located at the US Army Aviation Center (USAAVNC), Fort Rucker, Alabama. It is the only medical laboratory designated to deal with Army aviation's unique occupational problems.

In 22 years, the Laboratory has moved from being housed in one small wooden building to a large, modern facility. USARRL began with 7 personnel, now has has 152 personnel assigned. Our growth has been in research, people, and facilities, and we're proud of them all.

Under the direction and guidance of the USAMRDC, USAARL moves with the sure steps of maturity and responsibility of a firmly established research organization. The mission remains, through research, to preserve and enhance the health, safety, combat effectiveness, and survivability of the soldier. We are a blend of basic and applied medical research designed for timely responses to critical operational- and field-oriented problems.

This report gives an overview of USAARL during FY 84, identifies current areas of research, and gives a brief description of the research programs.

The DD Forms 1498 under which this research work is accomplished are contained in the appendix.

This report is prepared to fulfill the requirements of OTSG Regulation 70-31.

Management

Research liaison activities have been enhanced between USAARL and the Academy of Health Sciences with the establishment of the Academy of Health Sciences Medical Evacuation Proponency Office at Fort Rucker. Liaison activities continued with AVSCOM in St. Louis, Missouri, where USAARL's liaison office has become the central point of contact for the Army Medical Department.

During FY 84, the Laboratory received over 2,950 visitors. Included were distinguished visitors from Canada, the Federal Republic of Germany, Yugoslavia, United Kingdom, France, Israel, and Sweden. Visits also were conducted for the Commanding General and Deputy Commanding General of the US Army Medical Research and Development Command, the Deputy Commanding General of the US Army Health Services Command, the Chief of German Army Aviation, the Israeli Surgeon General, and members of the Army Science Board and National Research Council.

Support divisions

Headquarters

The headquarters group, in addition to the Commander, Deputy Commander, Executive Officer, Director, Programs and Plans, and Liaison Officer to Aviation Systems Command (AVSCOM), consists of the offices of the Adjutant/Detachment Commander, the Scientific Information Center, and the Resource Management Branch.

Office of Adjutant/Detachment Commander

The office of the Adjutant/Detachment Commander provides command and control over all military personnel to include personnel actions, disciplinary actions, billeting, and training. The Physical Security and the Information Security programs for the Laboratory are managed by this office. It also coordinates and supervises the administrative functions, postal services, and related office service operations of the USAARL headquarters.

Protocol affairs regarding visitors are supervised and coordinated in the Adjutant/Detachment Commander's office. During FY 84, the Laboratory received over 3,300 visitors, including distinguished visitors from the United Kingdom, Canada, Yugoslavia, the Federal Republic of Germany, France, Sweden, and Israel. Visits also were conducted for the Undersecretary of Defense for Research and Engineering, the Commanding General, Health Services Command, and several distinguished guests from the US Army Aviation Center and US Army Medical Research and Development Command.

Resource Management Branch

The Resource Management Branch provides services in fiscal and manpower management and civilian personnel administration. Other services, such as training and incentive awards programs, are administered by this branch.

During FY 84 USAARL underwent an organizational change which realigned manpower positions authorized in the Visual Sciences Group to create the Sensory Neurosciences Group. This organizational change was necessary to more closely align research elements under programmatic and professional groupings for execution of the approved mission.

A USAMRDC-sponsored Internal Review was conducted during FY 84 and found no discrepancies or regulatory violations within the Resource Management Branch. In addition, the Office of Personnel Management conducted a management study of USAARL civilian personnel actions concerning services and support provided by the Fort Rucker Civilian Personnel Office. The study resulted in a more positive relationship between USAARL and the Civilian Personnel Office.

Scientific Information Center

Plans were started to computerize the bibliographic records for the Scientific Information Center. Documentation for approval was begun and various integrated library systems were reviewed, including the system at the Army Library at the Pentagon.

More than 500 new books were added to the collection and five new journal subscriptions were added. The Scientific Information Center staff responded to more than 1,200 queries for information. Computerized database searches were offered using DIALOG, DTIC, and OCLC.

Research Systems Division

The Research Systems Division provides laboratorywide support in the areas of Biomedical Engineering, Data Systems and Instrumentation, Computer Applications and Services, Aviation, Veterinary Medicine, and Mathematical and Statistical Services. During FY 84, many instrumentation systems were designed, built, and installed; computer memory was expanded to four megabytes, user accounts were increased, and numerous user applications were developed; many missions were flown in support of research protocols and laboratory management; the animal colonies increased in size and plans were completed for a vivarium expansion; and many statistical analyses were conducted. Specific branch activities are detailed below.

Aviation Branch

Various research projects were supported by the Aviation Branch during FY 84. Projects that involved significant amounts of flight time included the investigation of the feasibility of flying by audio cues without visual reference and the testing of several cooling devices proposed for use with chemical protective ensembles. Numerous flights also were made to assure the timely arrival of personnel and equipment for the coordination and performance of research.

Training demands were particularly heavy on aviation assets in the past year. Three aviators received transitions into the U-21 aircraft and two newly assigned aviators attended the rotary-wing aviation refresher course. For one-third of the past year, the Laboratory was not staffed with the full complement of aviators authorized on the TDA, so the flying demands on the remaining aviators were high.

Biomedical Engineering Branch

Major instrumentation support for FY 84 included the completion of a system to monitor physiological parameters of test subjects in the USAARL helicopter flight simulator. Heart rate, skin and core temperatures, and respiration can be monitored, recorded, and plotted under computer control. Software also was made to determine interbeat intervals from EEG signals stored on a holter-type recorder.

Another computer-based system to gather data and control experimental parameters for use in the USAARL's Multi-Axis Vibration Laboratory was designed and assembled. The software developed will allow this system to move a target in a random fashion while acquiring target error data representing the subject's tracking ability. The data is stored for later analysis on the VAX computer.

A request by the Human Engineering Laboratory (HEL) for instrumentation support resulted in the assembly of a system to measure dummy response to gun firings in the Light Armored Vehicle (LAV). Field test data were gathered on the four coldest days in January at Aberdeen Proving Ground, Maryland, and later transferred to the computer at USAARL. This computerized data and hard copies of the acceleration traces were provided to HEL.

USAARL-designed circuitry was fabricated into a unit to display the aircraft flight parameters of bank angle and climb rate by auditory signals to the pilot. A successful test program was conducted in the UH-1H aircraft with several subjects.

The Helicopter In-Flight Monitoring System (HIMS) was set up for use in a research project investigating the heat stress of pilots in chemical defense (CD) clothing. This computer-based system and associated signal conditioning was supplied with signals from aircraft sensors and another instrument package constructed for monitoring physiological parameters of the subject. These units were maintained and checked throughout the 100-plus flights of the program. Associated with this project is the design of software (currently under development) to run on another computer to obtain the heart interbeat interval and respiration waveform from signals recorded on a two-channel holter-type recorder.

In support of a project to evaluate body armor for Army pilots, a lengthy study of available instrumentation equipment led to the designation of a system to meet anticipated need. Specifications for procurement were prepared.

Other support included an HEL-requested evaluation of the use of the HIMS and Raydist navigation systems for measuring pilot performance while wearing different CD masks, the breadboarding of a circuit to warn pilots in CD clothing of excessive heart rate over an extended period, and the design and fabrication of circuitry to monitor core temperature of tank crewmembers while in CD clothing.

Modeling and Simulation Branch

USAARL's central computer facility has continued to grow during FY 84. The VAX-11/780 computer memory was expanded to 4 megabytes and now serves 105 user accounts on 74 in-house terminals and 16 printers connected through a network of multiplexers developed by Data Systems and Instrumentation Branch. Dial-up access also is provided for field use and to support the Aviation Epidemiology Data Register project under an agreement with the Army Aeromedical Activity. Software capabilities also have grown with the addition of the BASIC language compiler, a ReGIS graphics library, a Forms Management System (FMS), a generalized linear model statistical analysis package (GLIM), and an administrative data management package (DATATRIEVE and Common Data Directory). The addition of word processing software and a spread sheet program is expected in early FY 85.

The Modeling and Simulation Branch has arranged extensive training opportunities for users of the USAARL VAX computer. There are on-line computer-aided instruction courses for the VMS operating system, the EDT text editor, and the DATATRIEVE data management program. In addition, classes on the VAX/VMS operating system, FORTRAN, and BASIC were conducted by Professor Constantine Roussos of Lynchburg College for 90 users on 5-6 January 1984, using a large-screen computer display in the USAARL Lecture Room. Personnel from BMDP, Inc., conducted basic training in the use of BMDP Statistical Software for 21 students on 31 May-1 June and advanced training for 15 students on 4-5 June 1984. Finally, basic training in the use of the SPSS-X Statistical Package was conducted for 21 students on 27 August 1984. Advanced SPSS-X training is planned for 1-4 October 1984.

The conversion of existing SYSTEMS 85 programs to the VAX system was completed in May 1984, following the successful addition of real-time data acquisition hardware to the VAX. This hardware makes it possible for the VAX to acquire digital and analog data from laboratory devices and special-purpose computers concurrent with timesharing use of the computer by Laboratory personnel.

Numerous applications were developed by VAX users during the past year. In addition to maintaining existing applications and providing daily advice and assistance to over 100 users, personnel of the Modeling and Simulation Branch developed software in support of the following special projects:

Aviation Epidemiology Data Register--Designed the data directory for aviator health physical data consisting of 178 fields (241 variables) and developing programs for data entry and summary listing in support of an agreement between USAARL and the Army Aeromedical Activity.

Gas Mask Evaluation--Developed several programs to analyze in-flight performance data collected by the Biomedical Engineering Branch using HIMS-II in a joint study with the Human Engineering Laboratory to evaluate a number of prototype gas mask designs based upon pilot performance during critical maneuvers.

Video Data Retrieval--Developed programs to acquire data from the EYENAC Video Data Retrieval System and verify operation of the video image tracker.

HIMS-II--Developed a system of programs to organize, manage, and process information acquired by the HIMS-II Airborne Data Acquisition System. This system successfully supported the Heat Stress Study conducted by the Biomedical Applications Research Division during the summer of 1984.

UH-1 Simulator--Developed a system of programs to acquire, organize, manage, and process real-time information from the UH-1 simulator. This system will support the study of atropine and other chemical warfare pretreatment drugs to be conducted by the Biomedical Applications Research Division beginning in October 1984.

Statistical/Mathematical Branch

A variety of statistical/mathematical support was provided for ongoing research studies. The main emphasis was placed on the statistical review of protocols/study plans for new investigations. This work was done under the auspices of the USAARL scientific review process. The statistical review work resulted in the preparation of reports reviewing the statistical aspects of the following protocols: "Aviator performance effects of chemical warfare antidote (atropine)"; "Pilot visual workload during instrument flight utilizing an integrated flight director/auto pilot system"; "Physical measurements of noise attenuation of hearing protective devices for typical impulse noise"; "Electrocardiographic response to the maximal graded exercise test: Phase I"; and "Blunt trauma effects of .50-caliber round defeat on personal body (chest) armor."

A major statistical effort was the development of an experimental design strategy for a headtracking performance study using a generic helmet. This work resulted in the preparation of a report "Toward a mathematical model of vibration head-neck stress and headtracking performance: Tentative outline." Following the preparation of that report, a consultation on this problem with the Mathematics Research Center, Madison, Wisconsin, resulted in the preparation of a report "Headtracking performance study: Design of experiments." The essence of that report, which contained the results of the conference was presented in a briefing to the Director, Biodynamics Research Division, and members of his staff and to the Director, Research Systems Division, and the members of his staff. In connection with this study, an assessment of a random (pseudorandom) number generator was provided to one of the principal investigators.

Work was done on the development of a statistical model (probability/stochastic) for an aviator's head movement during contour flight. The results of this mathematical modeling endeavor are to be incorporated into an appendix to a technical report. Dr. Box also was consulted for this work.

A final draft of a letter report titled "Statistical interim report: Some considerations of a mathematical model of neck muscle stress in US Army aviators" prepared in 1983 is undergoing slight revision due to the discovery of a new reference germane to the report. An abstract of this report was accepted by the XII International Biometric Conference held in Tokyo, Japan, during September. The US Army Research Office accepted an

abstract of a paper titled "Some experiment design considerations for an investigation on neck stress/endurance in helicopter pilots" for presentation at the US Army Thirtieth Conference on the Design of Experiments in Army Research. The conference will be held at Las Cruces, New Mexico, during October 1984.

Statistical/mathematical advice or consultations also were provided or analysis done for the following studies: Distance estimation using night vision goggles (design of experiment); Blunt trauma effects of .50-caliber round defeat personal body (chest) armor (experiment design strategy using the "up-and-down" method of experimentation); and a suggested analysis for multivariate data from a study of aviator's eye movement during different maneuvers and aircraft with suggestions on how to interpret the results of multivariate analysis in a partially hierarchal design configuration.

Statistical advice and counsel was provided to the US Army Safety Center via a letter on the development of a mathematical model of time series in connection with their reporting of accident statistics. A variety of statistical mathematical advice and counsel was provided to USAARL personnel on a miscellany of problems.

During the year, many scientists expressed a desire to have a tutorial/short course on the design of experiments held at the Laboratory. The US Army Research Office, Division of Mathematics, provided information on such a tutorial and the administrative steps required to obtain this course. Their information was collated and approval of a request for this tutorial is pending.

Veterinary Medicine Branch

During FY 84, the animal facilities went through a process of change and internal growth. Two new animal care specialists have been assigned, along with a new veterinarian. The increase in the number of animal caretakers will improve individual attention and the environment of the animals.

The chinchilla production colony has remained constant as far as production is concerned, but an increase in infant deaths, along with the deaths of many active breeders, has resulted in an overall decrease in population. The cause of the increased number of deaths has been attributed to an inconsistency in room temperature due to mechanical malfunction and pseudomonas infection passed through the water of Building 6902.

The cat colony has experienced many disease outbreaks. Among these are upper respiratory disease syndrome, feline infectious anemia, and heartworms. Adult heartworms in cats have never been documented before. Cats have an immune system which stops microfilaria from traveling in the body after being infected from a mosquito; therefore, the recorded cases of heartworms in cats have caused only some local damage to the tissue at the vessels where the adult heartworm would live and grow. This case of adult heartworms in cats has been documented and photographed. We are awaiting a literature search to determine if anyone else recently has documented a similar finding. If not, our documentation will be published.

The production colony of Galago crassicaudatus (bushbabies) has been issued to Vanderbilt University. Eight bushbabies will be retained to complete ongoing experimentation.

Plans to modify the existing vivarium to consolidate all animal care facilities, i.e., surgery, treatment, necropsy, etc., under one roof are ongoing. We will begin construction shortly. Completion of the modification and final installation of various automated animal care systems will result in state-of-the-art animal facilities.

Data Systems and Instrumentation Branch

The FY 84 work effort was distributed laboratorywide with support provided toward preparation for three scheduled research projects: heat stress effects, effects of chemical warfare antidotes, determination of helmet weight and variable center of gravity; and one unscheduled project which required a quick support response, a tank study at Fort Knox, Kentucky. A special emphasis continues to be placed on improvements to data collecting capabilities of the research systems in the Laboratory.

The multi-axis vibration system (MAVS) has been reconfigured to support the helmet weight and center-of-gravity study. This included the reinstallation of the moving target system (MTS) and fabrication of minicomputer interfaces to drive the MTS. The combination of these two systems will furnish vibration and eye-tracking stimuli.

The helicopter operational trainer (HOT) has been prepared to support the Chemical Warfare Antidote Study (Phase I). This included a direct hookup with the VAX for data collection and the installation of a remote radio system for the medical monitor.

The support provided for the heat stress study included installation and maintenance of the helicopter instrument measuring system (HIMS-II) used in the USAARL research helicopter. Various installations were made and power systems were furnished to meet the requirements of three cooling systems used in the study.

Other support to research divisions and the Laboratory included:

1. The installation of a laboratorywide data communication network to be used with the VAX-11/780 computer. This includes the installation of a cable network, multiplexers, modems, terminals, and printers.

2. Continued support to the Biomedical Engineering Branch on new proposals or various data collection systems.

3. Maintenance and support of hydraulic power supply for the MTS single-axis vibration system and the MTS impact system. A turn-on and operation procedure has been written for the MTS.

4. One member of the branch coauthored a report titled Automatic gain control circuit for video signals of scenes of varying illumination levels, USAARL Report No. 84-9.

Technical and Logistical Services Division

The Technical and Logistical Services Division (T&LS) provides total support to Scientific Arts, Laboratory Crafts, Facilities Engineering and Maintenance, Equipment Maintenance, Supply and Acquisition, and Property Management. The division provides support to the Laboratory and its research mission by planning, coordinating, and implementing technical, logistical, and maintenance programs.

Supply Branch

The Supply Branch prepares and submits purchase orders for nonstandard supplies and equipment with proper authorization and justification as well as requests, sorts, and issues all standard and nonstandard supplies. This branch acts as the technical liaison between researchers and the Fort Rucker procurement office for establishing high-dollar contracts to support the USAARL research mission.

The researchers are assisted by supply personnel in composing justification for purchasing equipment and supplies. The Mission Support Supply Account, a formal account that allows for bypass of standard procedures, also is managed by the Supply Branch. The Supply Branch operates a self-service account and maintains and conducts searches utilizing literature, catalogs, and supply regulations.

From the warehouse area, expendable supplies may be acquired, as well as other small items requested. Large and heavy items are delivered to the division by personnel of the Supply Branch. During FY 84, over 1,000 purchase requests were submitted, of which a large percentage required special handling.

A major accomplishment for the Supply Branch was the development and updating of a new tracking system for providing immediate and up-to-date status of all supply items valued at over $3,000.

When required, USAARL Supply is responsible for procurement of controlled drugs from Medical Supply, Lyster Army Community Hospital, the accountability for the drugs, and the issue to the USAARL Controlled Substance Officer.

The realignment and new SOP for incoming products aligns the Supply Branch's formal account with the traditional operation of a formal account and separates all actions that have caused confusion with past performance. Now there exists a clear definition of supply, property, receiving, storing, and transportation duties and responsibilities.

Facilities Management

The building engineer monitors all of the facility's maintenance planning and new construction. He assists in the approval, planning, design, and modification of facilities. Supervision and inspection also is accomplished from this office.

FY 84 was the second full year of facilities contract maintenance where contractors provided outstanding work under the guidance of the building engineer. This was a first-ever type of service agreement at Fort Rucker. Representatives of this office have supervised the correction of many construction deficiencies and malfunctions during FY 84, as well as installation of an incinerator and sterilizer, vibration test system, shell test facility, and modification of a chemical defense laboratory to comply with security requirements for the Chemical Defense Project.

Presently, work is underway for the construction of a testing facility; and plans are being made to house the remaining part of the acoustics facility, which now is located in the old hospital area. Plans are underway for modification of the vivarium and installation of a new simulator. Work with the Directorate of Engineering and Housing and Procurement Divisions to obtain a new maintenance and custodial contract for the next 4 years also is underway.

Laboratory Crafts

The Laboratory Crafts Branch plans, designs, and fabricates intricate and commercially unavailable and special scientific equipment, tools, and fixtures to meet specific research project demands. Its personnel are technically proficient in identifying and understanding the researchers' needs.

Shop personnel continue their support by processing items necessary to meet the research needs. Among the items requiring special work are components for the cooling vest studies, High Falls heat stress project, Fort Knox heat stress project, known weight calibration of the high- and low-frequency vibration table, as well as many small modifications and fabrications.

Due to medical reasons, one man is on sick leave pending retirement. This situation causes a backlog of projects and prolongs their completion dates.

Maintenance

Maintenance personnel provide maintenance, repair, and calibration of all nonreal property (excluding aircraft) in the Laboratory. Performance of maintenance is provided by one or more of the following: in-house support, post intracontracts, one-time support contracts, or continuing service contracts. This branch maintains historical data on all equipment, monitors items under the Army Warranty Program, and provides technical information needed for new procurement. Branch personnel have technical knowledge of laboratory equipment, as well as being knowledgeable of how the equipment relates to the research efforts.

During FY 84, two technicians were hired. With these personnel, the Maintenance Branch has been able to provide better support for the medical equipment within USAARL. In addition to performing scheduled and nonscheduled services, the support personnel have been used to update the maintenance records concerning scheduled services. The correction of scheduled services data will give the maintenance manager a more realistic view of the workload.

Property Management

This section acquires and maintains control of all expendable and nonexpendable supplies for USAARL through checks, labeling, and hand receipts of all incoming equipment required in support of the Laboratory's mission. It is responsible for all equipment authorizations including tables of distribution and allowances (TDA), common tables of allowance (CTA), letters of authorization, etc. Property management monitors the excess equipment program, turn-in of equipment, and other equipment losses or gains, and insures that durable supplies are handled in an efficient and cost effective manner. References and property management services are provided to all laboratory personnel.

Ending FY 84, the value of the property book was $12,774,635. This included 2,593 lines with 5,566 items. Command emphasis on property accountability was evident by the increased awareness by hand receipt holders of their responsibilities in safeguarding government property. This was stressed greatly during the year.

A significant element of the FY 84 Command Supply Inspection and a Department of the Army (DA) area of special interest was verification of the property account inventory accuracy which was determined to be 100 percent for the third consecutive year.

Scientific Arts

Scientific Arts provides scientific and technical photography, medical and scientific illustration, engineering drafting, motion picture data collecting and documentation, projection services for scientific presentations, and related audiovisual services for all USAARL research functions. An unusual feature of this section is that each person assigned to a project becomes totally involved with the project by becoming a team member and working directly with the project officer.

With the use of automatic processing equipment, all research photographic support has been provided by only two full-time employees. Many illustration and drafting hours were saved by the use of researcher-submitted computer data.

Work is continuing on preparation of a database for rapid retrieval of scientific arts data for reprint, duplication, and/or modification.

This branch produced 13,503 units of still photo work, 12,800 feet of motion picture footage, and 1,190 units of graphic arts work. These figures encompass the 764 work orders completed during the fiscal year.

Funding

Customer-funded projects

In direct compliance with our mission to conduct research and development to eliminate health hazards associated with military manned systems and to assist combat mission planners and materiel developers to recognize these hazards early in the development process, USAARL maintains a program of active research and consultation with doctrine and materiel development agencies. This problem-solving research program allows Laboratory personnel to apply their specific research expertise to emerging systems, thus providing vital support to developers who do not possess in-house personnel qualified to conduct such research. These customer-funded research projects, while serving the requesting agency, also allow USAARL to increase the information base within the established scientific research programs.

There were 13 customer-funded projects in FY 84---5 brought forward from FY 83 and 8 new projects. The projects, funding agencies, and brief progress reports are shown below:

TITLE:	Measurement of head and chest acceleration of tank gunner during gun firing
FUNDED BY:	Naval Surface Weapons Center, Dahlgren, VA; Human Engineering Laboratory (HEL), Aberdeen Proving Ground, MD
INVESTIGATORS:	James A. Lewis and Donald Schneider

Objective: To measure the head and chest accelerations imposed on the gunner during the firing of the tank gun. This information is needed to support the design requirements for the Mobile Protected Weapons System/Mobile Protected Gun program. There is some concern about the ability of the tank gunner to perform effectively when subjected to the recoil of the large caliber guns mounted on lightweight air-mobile tanks. A program has been initiated by HEL in concert with the Marine Corps and Navy to investigate the problem.

Progress: The tests on the M-60 and M-551 tank gun firings were completed; and the USAARL center-of-gravity dummy was retrieved from the Yuma Test Range, instrumented, installed, and tested in the Tank Command's ride simulator at Warren, Michigan. Project completed.

TITLE:	Development of a test method of evaluating the effectiveness of helmet retention systems
FUNDED BY:	Naval Air Development Center, Warminster, PA
INVESTIGATOR:	Joseph L. Haley, Jr.

Objective: Helmet loss during ejection and parachute opening continues to be a problem for the US Navy. Current helmet retention system tests are not adequate for evaluation of the Navy's flight helmets. The Navy has requested USAARL provide dynamic test criteria suitable for the qualification of helmet retention systems to be used in an ejection seat or crash environment.

Progress: The testing of the flight helmets was completed in the first quarter FY 84. The tests revealed that the Navy's SPH-3C dual visor helmet with the single snap chinstrap came off the headform due to the failure of the "pull-the-dot" fasteners. All other helmets remained on the headforms in the tests, and the degree of displacement and/or rotation on the headforms will be determined from the film analysis. Project completed.

TITLE:	Acoustic evaluation of samples of helmet compatible communication/ aural protective system (HCCAPS)
FUNDED BY:	US Army Natick Research and Development Command, Natick, MA
INVESTIGATOR:	Ben T. Mozo

Objective: To determine the electro-acoustic characteristics of the "talk-through" circuit and the hearing protective characteristics of the muff system, to include distortion frequency response and acoustic output-using device in combination with insert protection.

Progress: Two production samples of Type I and Type III were delivered to the Laboratory in February 1984. The devices were evaluated for attenuation using the real-ear method and a physical measurement method. The devices did not meet the requirement of the contract at the frequencies below 3 kHz. Additional testing was completed in an attempt to determine the cause of the low attenuation of the HCCAPS. The data indicated open cell foam in the cavity provided improved attenuation for the lower frequencies. Latest production models were delivered to the Laboratory in June 1984. These versions are being evaluated for attenuation frequency response and active protection operation.

TITLE:	Calibration of headsets for weaponeer training device
FUNDED BY:	Naval Training Center, Orlando, FL
INVESTIGATOR:	Ben T. Mozo

Objective: To determine the frequency response and sensitivity of the headsets. Progress: Results of 100 weaponeer headset evaluations were furnished to the Naval Training Center in August 1984. Project completed.

TITLE:	Instrumented anthropomorphic dummies for airdrop testing
FUNDED BY:	Yuma Proving Ground, Yuma, AZ
INVESTIGATOR:	Roy Maday

Objective: To monitor the Test and Evaluation Command parachute test to determine the potential for injury from jumps in excess of 200 knots airspeed.

Progress: Testing is still pending. Problems with parachute equipment have not been corrected.

TITLE: Evaluation of protective characteristics of SPH-4 helmet against criteria

FUNDED BY: US Army Natick Research and Development Laboratories, Natick, MA

INVESTIGATORS: Joseph L. Haley, Jr., and Roy Maday

Objective: To conduct an assessment of the protective characteristics of the modified SPH-4 helmet against criteria set forth in MIL-H-43925.

Progress: Impact evaluation test and chinstrap pull test were conducted on the helmet supplied with 3/4-inch thick foam liners. The helmet meets all criteria stated in MIL-H-43925. However, it should be noted that the improved helmet did not include any change in the existing hard plastic earcup. It is highly desirable that the helmet include a crushable earcup. Project completed.

TITLE: Engineering support of the Army integrated flight helmet (HGU-56)

FUNDED BY: Aviation Systems Command (AVSCOM), St. Louis, MO

INVESTIGATORS: Joseph L. Haley, Jr., William E. McLean, and Ben T. Mozo

Objective: To provide design criteria as needed/required during contractor development phase of HGU-56.

Progress: USAARL provided technical representatives at all quarterly program reviews at the contractor's facility, and also hosted two contractor visits at Fort Rucker to check the compatibility of the HGU-56 with the cockpit systems of most Army aircraft. The prototype HGU-56 helmets are scheduled to be evaluated by the Laboratory in the first quarter of FY 85.

TITLE: Chemical analysis of urine samples collected during SCOUT I operations

FUNDED BY: US Army Aviation Board, Fort Rucker, AL

INVESTIGATOR: Philip L. Taylor

Objective: To measure by biochemical indicators stress levels of pilots and copilots during SCOUT I operations.

Progress: Measurements gave the general implication that a dedicated pilot is capable of performing the aviator duties as required by the flight profiles of SCOUT I with no greater biochemical indication of stress or fatigue than when the piloting duties are shared between pilot and copilot. Project completed.

TITLE: Visual, optical, and acoustical testing of the AH-64 CB protective mask

FUNDED BY: US Army Test and Evaluation Command, Aberdeen Proving Ground, MD

INVESTIGATORS: Clarence E. Rash, Ben T. Mozo, and William E. McLean

Objective: To evaluate the current version of the AH-64 CB protective mask in the areas of optical quality, durability, and acoustical attenuation.

Progress: The tested version of the AH-64 CB mask is considered to meet the requirements of providing adequate acoustical attenuation and optical quality for AH-64 pilots in situations necessitating the use of CB protective garments. Project completed.

TITLE: US Army motorcycle helmet evaluation

FUNDED BY: US Army Natick Research and Development Laboratory, Natick, MA

INVESTIGATORS: Joseph L. Haley, Jr., and Ben T. Mozo

Objective: To provide design criteria and evaluation as needed/required.

Progress: USAARL provided technical representatives at three helmet development meetings. A contract has been awarded for construction of prototype motorcycle helmets which USAARL will evaluate and test in the second quarter of FY 85.

TITLE:	Visual and optical analyses in support of engineering design test on the XM-40 and British S-10 protective masks
FUNDED BY:	US Army Chemical Research and Development Center, Aberdeen Proving Ground, MD
INVESTIGATORS:	Clarence E. Rash and William E. McLean

Objective: To optically evaluate six candidate protective masks.

Progress: The masks were delivered in mid-August and testing is in progress. Preliminary report is expected by the end of October 1984.

TITLE:	Measurement of dummy response to gun firing in the light armored vehicle (LAV)
FUNDED BY:	Human Engineering Laboratory (HEL), Aberdeen Proving Ground, MD
INVESTIGATOR:	James A. Lewis

Objective: To measure head and chest accelerations of instrumented dummy during firings at Aberdeen Proving Ground. Provide data in time-history hard copy and 9-track digital tape format.

Progress: The field testing was conducted as planned in January. The data collected was transferred to the USAARL VAX computer for production of hard copy tapes and 9-track digital tape as requested. Analysis of the data will be done by HEL and their contract personnel. Project completed.

TITLE: Production item testing of the integrated helmet unit of the Integrated Helmet and Display Sighting System (IHADSS)

FUNDED BY: Advanced Attack Helicopter Program Manager's Office, St. Louis, MO

INVESTIGATORS: Clarence E. Rash, William E. McLean, Joseph L. Haley, Jr., and Ben T. Mozo

Objective: To evaluate the production line version of the IHADSS helmet in the areas of acoustic attenuation, optical quality, crash protection, and biodynamic performance.

Progress: Two integrated helmet units were evaluated. They were found to meet acoustical and optical requirements. Failures were noted in the chinstrap retention system. Final report provided. Project completed.

Contracts

Many universities conduct research programs that parallel the research requirements of the US Army. The Army provides funding for these programs and receives the benefit of the research. During FY 84, 10 research proposals were submitted for review. Of these, one was funded and two were favorably recommended for funding by other US Army Medical Research and Development Command laboratories.

TITLE:	Hearing protection against low frequency weapon noise
CONTRACT NO.	DAMD 17-82-C-2105
CONTRACTOR:	Auburn University, Auburn, AL
INVESTIGATOR:	R. M. Broughton, Jr.

Objective: The objective of this research is to discover what material properties are responsible for noise attenuation in foam earplugs. Recommendations then should be possible for materials and construction of an improved earplug.

Progress: A relationship between the physical characteristics measured and sound attenuation at low frequencies was not found to be consistent. The conclusion was made, based on the experimental results, that energy absorption of the earplug is not the primary mechanism for noise attenuation. In addition, the cell structural characteristics, density, or chemical content do not show causal relationships with noise attenuation of foam earplugs. One foam sample (not a marketed earplug) gave exceptionally high attenuation for frequencies below 200 Hz. Additional tests, not under contract, are being conducted at Auburn by the principal investigator. Contract completed.

TITLE:	Development of auditory localization test procedure
CONTRACT NO.	DAMD 17-80-C-0109
CONTRACTOR:	University of Texas at Dallas, Richardson, TX
INVESTIGATOR:	R. P. Hamernik

Objective: To determine extent of damage to the cochlea from noise exposure.

Progress: Impulse noise exposure has been completed on an additional 23 animals. These chinchillas were behaviorally trained to obtain pre- and postexposure audiometric data. Two studies covering the research during the 1980-83 period are being written for publication. These are: "The value of peak pressure of an impulse in the prediction of the auditory hazards of exposure" and "The relation between peak pressure and total number of impulses in the production of hearing loss and cochlear pathologies."

TITLE:	Statistical analysis of helicopter pilot performance during instrument flight across repeated flights
CONTRACT NO.	DAMD 17-81-C-1174
CONTRACTOR:	Jacksonville State University, Jacksonville, AL
INVESTIGATOR:	Gary Yonker

Objective: Flight commanders must have as much information as possible concerning the length of time that helicopter pilots can safely and successfully fly during extended operations. Examination of pilot performance data during simulated extended operations along with concurrent visual performance data will facilitate a description of the total primary workload of aviators during IFR conditions, and will allow an assessment of any degradation of performance which may occur.

Progress: Data from a week-long simulated extended operations study were examined with respect to methodological issues associated with the assessment of helicopter pilot performance (including visual performance) and the potential impact of extended flight schedules on pilot performance.

Results indicated that no significant change in pilot performance (psychomotor or visual) over the week of extended operations could be identified. Based on the research results, methodological issues and recommendations for future studies were addressed. Contract completed.

TITLE:	Neck muscle endurance and fatigue as a function of helmet loading: The definitive mathematical model
CONTRACT NO.	DAMD 17-80-C-0089
CONTRACTOR:	Wright State University, Dayton, OH
INVESTIGATOR:	C. A. Phillips

Objective: To provide objective data to complete the predictive model which USAARL can use in writing specifications for helmet weight and center-of-gravity placement. Such data will help minimize helmet development cost and maximize efficiency in the wearer of protective headgear by reducing helmet-induced fatigue.

Progress: The remaining subject volunteers completed all phases of human testing. The accumulated data was reduced and resultant endurance times for the various weight and center-of-gravity combinations were compiled as input for a definitive mathematical model. The primary equations for the model were derived based on a piece-wise linear analysis of the system. This was a deviation from the original plan to model the system using a multiple regression analysis and 12 equations. The original plan was abandoned due to the complexity of the system resulting in a piece-wise linear analysis using 720 equations. A computer program was developed to predict neck muscle endurance times for various helmet weights and centers-of-gravity within the boundaries of the experimental conditions. In addition, a statistical package was developed which was specifically tailored to this model. This package shows the statistical significance of results of multiple predictions using the mathematical model and varying center-of-gravity, weight, and location.

TITLE: The effect of helicopter vibration on the spinal system

CONTRACT NO. DAMD 17-82-C-2153

CONTRACTOR: University of Vermont, Burlington, VT

INVESTIGATOR: M. D. Pope

Objectives: To measure volunteer response to three axes of UH-1 helicopter vibration in age-matched females and males. To establish the relationships between vibration posture and possible causes of low back pain in the Army rotary-wing aviator.

Progress: Data collection for electromyographic (EMG) frequency shifts, vibration transmissibility, and impedance almost is complete for all three axes of vibration. Corresponding discomfort ratings using a visual analog scale (VAS) also is complete. Data collected is from 10 male and 10 female subjects exposed to single axis vibration for 2-hour periods. Data revealing changes in spinal contours resulting from vibration exposure using a Moire-fringe analysis technique remains to be accomplished. Analysis of data collected to date has just begun.

TITLE: Characterization of the photo-receptor population in the retina of the bushbaby

CONTRACT NO. DAMD 17-82-C-3066

CONTRACTOR: University of Florida, Gainesville, FL

INVESTIGATOR: G. M. Hope

Objectives: To qualitatively and quantitatively analyze the photoreceptor population of the bushbaby, Galago crassicaudatus. To determine the kind of photoreceptors present, affinity differences between photoreceptors to different histochemistry techniques, and ultrastructural differences between receptor cells. To conduct a morphometric assessment of photoreceptor densities and distributions across retina. To perform a detailed ultrastructural analysis of photoreceptors.

Progress: None of the cone-specific labeling procedures indicated the presence of cone-like photoreceptors in the bushbaby retinas, although all except one clearly and unambiguously labelled cones selectively in the cone-bearing mongoose retina. Exhaustive examination of Galago retinas failed to disclose conclusive evidence of cones. No cone-like nuclei and pedicle-like synaptic endings were found. Quantitative evaluations were undertaken to determine the distribution of the distinctive nuclei in the two major meridians of the retina. Preliminary results of this analysis indicate that these structures are randomly scattered throughout the retina. No area of high concentration was found, even in the central retina. No distribution pattern could be discerned in the quantitative data. Contract completed.

TITLE:	The effects of blast trauma (impulse noise) on hearing: A parametric study
CONTRACT NO.	DAMD 17-83-G-9555
CONTRACTOR:	University of Texas at Dallas, Richardson, TX
INVESTIGATOR:	R. P. Hamernik

Objective: The objective of this study is to extend the biological database relating parameters of impulse noise to auditory injury.

Progress: Evoked response audiograms and evoked response tuning curves were obtained from three groups of chinchillas before and after exposure to impulse noise. One group (N=5) was exposed to 10 impulses (1 msec A-duration) having a peak SPL of 150 dB. This group sustained rather small permanent threshold shifts (PTS) ranging from 0 to 9 dB and showed little or no broadening of the tuning curves. A second group (N=5) was given the same exposure, but at a higher level, 155 dB. The PTS for the second group was about the same as the first, about 2 to 13 dB, and the tuning curve showed only minor changes after the exposure. A third group (N=4) of chinchillas was exposed to a single impulse (1 msec A-duration) at 155 dB SPL. This group suffered temporary threshold shifts of between 10 and 20 dB. Presently, the PTS measures are being obtained. The cochleas of the animals are in the process of being analyzed histologically.

TITLE:	The personal monitor and communicator: An electronic dogtag
CONTRACT NO.	DAMD 17-83-G-9559
CONTRACTOR:	Purdue University, West Lafayette, IN
INVESTIGATOR:	W. A. Tacker

Objective: To develop a personal medical monitor for the soldier which would be worn much like a wristwatch or dogtag and could (1) acquire vital signs, (2) acquire environmental data, (3) carry medical history, and (4) transmit information to command headquarters. The device would be used in the field for (1) triage by medics (both under conventional and integrated battlefield conditions), (2) monitoring during evacuation, (3) battalion aid station and field hospital monitoring, (4) monitoring chemical and radiation exposure, (5) transmitting the data given in items 1 through 4, and (6) locating the wearer(s).

Progress: Human subjects have been tested to select a totally safe, painless, but very noticeable electric stimulus. Devices have been built to test subjects to determine optimum electrode-stimulus combinations. A remotely activated, wrist-worn stimulator has been designed and constructed. Three generations of prototype devices have been built and tested to measure pulse and respiration rates and motion from changes in wrist impedance. A wrist-worn device to telemeter heart, motion, and respiration data is under construction. A hybrid prototype is in final design stages. Available technology is being investigated to determine appropriate communication frequencies for locating injured soldiers. Technology for on-site assembly of the prototype units has been selected. Preparations to use this technology include personnel training and equipment acquisition. To aid in system design, operational scenarios have been developed to demonstrate the usefulness and limitations of the system for a range of field conditions. These scenarios have been developed with the aid of Army medical officers, nurses, and enlisted medics, as well as research and development personnel.

TITLE:	Continuing support of the ASA standards program
CONTRACT NO.	DAMD 17-83-G-9545
CONTRACTOR:	Acoustical Society of America, New York, NY
INVESTIGATOR:	A. Brenig

Objective: To maintain accurate standards in acoustics, coordinate technical expertise to provide United States positions and inputs to international standardization efforts and documents, and coordinate US representation to international meetings in acoustical standardization and subcommittee and working group meetings.

Progress: Three accredited standards committees, S1, S3, and S12, were administered during this period. Semiannual committee meetings of each committee were held and minutes provided to the users. Working groups under each committee have continued the process of preparation, review, and revision of standards within their chapter. Coordination of various International Standards Organization (ISO) standards have been accomplished.

TITLE:	Auditory evoked potentials as a function of sleep deprivation and recovery sleep
CONTRACT NO.	DAMD 17-84-C-4084
CONTRACTOR:	Bowling Green State University, Bowling Green, OH
INVESTIGATOR:	P. Badia

Objective: To determine if P300 neurophysiological events are sensitive to sleep deprivation (48 hours); to determine the correlation of P300 events with the traditional psychological/ psychomotor events; and to document the restorative efforts of short sleep on P300 events and traditonal measures. This information will determine if this new and controversial technology should be evaluated in the Army's field setting as a means of monitoring and predicting sleep deprivation associated with performance and decision-making decrements.

TITLE:	Computer modeling and optimization of OBOGS with contaminants
CONTRACT NO.	DAMD 17-83-C-4076
CONTRACTOR:	University of Texas at Austin, Austin, TX
INVESTIGATOR:	J. J. Beaman

Objective: To develop a computer model of molecular sieve oxygen generation systems which includes bed temperature variation, altitude (pressure changes), and effects of contaminants. This model can be used to optimize onboard oxygen generation systems (OBOGS) for use in helicopter, medevac, and field hospitals. The model should run on USAARL computers, VAX or PDP 11/24.

Progress: New contract; no progress report to date.

Small Business Innovation Research

Each year, in compliance with the Small Business Innovation Development Act of 1982, the Department of Defense (DOD), through its subordinate agencies and commands, invites small business firms to submit research proposals for funding consideration. The Small Business Innovation Research (SBIR) program is directed at providing encouragement for small firms in the private sector to accomplish contracted efforts relevant to DOD needs.

USAARL sponsored six SBIR contracts during FY 84:

TITLE:	Artificial intelligence/robotic supplement to medical support
CONTRACT NO.	DAMD 17-84-C-4049
CONTRACTOR:	Computational Mechanics Consultants, Knoxville, TN
INVESTIGATOR:	R. L. Andrews

Objective: To conduct a feasibility study for a soft end-effector system. The design approach is toward development of a sensitive modular device capable of object recognition and lifting capability applicable to automated and semiautomated casualty retrieval systems.

Progress: The overall results indicate that sufficient research data and experience exists to effectively apply a modular, intelligent, and relatively general-purpose first generation sensitive end-effector system in support of field and hospital medical care. Final report submitted.

TITLE:	Artificial intelligence/robotic supplement to medical support
CONTRACT NO.	DAMD 17-84-C-4051
CONTRACTOR:	Environmental Energy Systems, Inc., Alexandria, VA
INVESTIGATOR:	R. D. Bishop

Objective: To determine the feasibility of developing a robotic vehicle capable of entering a battlefield, locating and retrieving casualties, and returning them to the rear for treatment. The vehicle would be monitored and directed from a control van in the rear.

Progress: The major conclusion is that the system conceived could be fielded in the 1980s and would immediately offer half the idealized lifesaving potential that might be envisioned even with the most futuristic and sophisticated 21st century system. The secondary conclusion is that the artificial intelligence applications for saving lives on the battlefield are not yet within the state of the art. However, the early system can be justified for its own sake; subsequent improvements easily can be added in an evolutionary, building-block fashion. Final report submitted.

TITLE:	Electric robotic medical support vehicle
CONTRACT NO.	DAMD 17-84-C-4050
CONTRACTOR:	Unique Mobility, Inc. Englewood, CO
INVESTIGATOR:	J. S. Gould

Objective: To evaluate the technical concept of a wheel-mounted electric drive permanent magnetic motor in combination with a computer-controlled vertical strut suspension system. This concept, in later phases, will lead to the development of a computer-controlled robotic casualty retrieval vehicle.

Progress: The concept of a permanent magnetic motor was evaluated and found to be feasible and capable of providing the same amount of power of conventional motors, but at less than one-half the size and weight. A design was selected and optimized.

TITLE: Remote operated medical support vehicle

CONTRACT NO. DAMD 17-84-C-4052

CONTRACTOR: Standard Manufacturing Co., Inc. Dallas, TX

INVESTIGATOR: R. J. Schwarz

Objective: To investigate the most reliable approach to developing a remote-controlled medical support vehicle capable of entering rough terrain and hostile environments for the purpose of retrieving casualities.

Progress: It was determined that the present technology can provide the necessary hardware to develop a workable remotely operated medical support vehicle. Design and operational characteristics were evaluated for such a vehicle. Applications for a robotic medical vehicle were investigated. Final report submitted.

TITLE: Computer graphics control system

CONTRACT NO. DAMD 17-84-C-4198

CONTRACTOR: SYSTEX, Inc., Beltsville, MD

INVESTIGATOR: Lorenzo F. Exposito

Objective: To develop computer graphics control system utilizing government-owned LS1-11/23 Genisco GCT-3000 hardware and develop software for visual research applications.

Progress: New contract; no progress to date.

TITLE: Survey of extended wear contact lenses for potential use by combat aircrews

CONTRACT NO. DAMD 17-84-C-4199

CONTRACTOR: Visidyne Corporation, Conroe, TX

INVESTIGATOR: William J. Benjamin

Objective: The technical evaluation of available extended-wear contact lenses for potential use by aviation personnel. Provide DA with the contact lens or lenses that offer the greatest potential for military aviation application.

Progress: New contract; no progress to date.

Personnel

USAARL continued to support the upgrading of skills of its personnel. Special emphasis was given to training all personnel in the use and operation of the VAX computer and associated software. One hundred and thirty military and 153 civilian employees received training and professional development during FY 84. This includes 67 military and 99 civilian personnel who received training on the VAX and associated equipment and software. This training was conducted on site at a cost of $27,614, representing a substantial savings over TDY costs.

Among the Laboratory's professional staff, personnel have earned 27 doctorates, 18 masters, and 25 bachelors degrees.

Mandatory training requirements were met by all military personnel. In the skills qualification testing for FY 84, USAARL military personnel had a 99 percent pass rate. Seven persons reenlisted or extended their enlistments for a 25-year total.

Personnel by category

Category	Authorized
Professional	51
Scientists	[illegible]
Engineers	[illegible]
Others	[illegible]
Skilled technicians	60
Administrative	10
Clerical	33
TOTAL	154

Personnel achievements

Civilian awards

Special Act Award	6
Sustained Superior Performance Award	5
Exceptional Performance	31
Quality Step Increase	1

Military awards

Meritorious Service Medal	2
Army Commendation Medal	3
Army Achievement Medal	4

Promotions

Military

Officers	1
Enlisted personnel	9

Civilians

Permanent	11
Temporary	6
Co-Op student	3
Junior fellowship	1

Special recognition

Soldier of the Year	SP5 Rebecca Allen

Co-op program

Due to reduction in commandwide hire lag, the Cooperative Education Program continued with six spaces for the program. Future students will be hired provided an authorization exists to support the hire.

A total of nine students were in Co-Op roles in FY 84. Two of these were new students and three were graduate students. Requirements existed for the following job series: electrical engineering, mechanical engineering, biomedical engineering, research psychologist, microbiologist, and physiologist.

During FY 84, the following universities were represented with cooperative education students: Tuskeegee Institute, Clemson University, Auburn University, University of Alabama, Wright State University, and University of Southern Mississippi.

Equal Employment Opportunity (EEO) Program

Affirmative action continued to be emphasized at USAARL. FY 84 accomplishments include the following:

Black employees: The total number of Black permanent employees increased by one, increasing Black representation to 8 percent from 7 percent. The average grade remained at 9.0. One Black female was detailed to a GS-11 budget officer position. One Black female was promoted to GS-11 from GS-9. One GS-7 Black male was hired. Twenty-three training courses were provided for Black employees. Twelve of these involved TDY. One Black female was given an Exceptional Performance Rating. There were two opportunities to select Black emplovees in permanent positions in FY 84. Black employees were selected in both situations. One Black employee was recruited and hired for a professional GS-13 position, but resigned; the other Black employee was selected and

hired for a GS-7 laboratory technician position. There continues to be underrepresentation in total numbers of employees with five Black employees, or 8 percent.

Hispanic employees: USAARL's total number of Hispanic employees remained the same. Average grade remained GS-7. The basic problem continues to be the small number of Hispanics in the civilian labor force. The number of Hispanic employees is one, or 2 percent.

Women employees: The total number of women employed remained at 29 or 48 percent. This is above the civilian labor force statistics. The average grade rose from 5.86 to 6.07. This was due to the following internal promotions: one White female was promoted to budget officer GS-12; one Black female was promoted to budget analyst GS-11; two White females were promoted to supply clerk GS-5; one White female was promoted to statistical assistant GS-6; and one White female was promoted to clerk-stenographer GS-4. The average grade for women at 6.07 is in contrast to the average grade for men at 10.97. There is no overall underrepresentation of women, but there is underrepresentation at the professional level and above the GS-12 level for women in USAARL.

Handicapped employees: USAARL has two permanent handicapped employees, an increase of one from the last reporting period. One handicapped person was referred and one was hired.

Other accomplishments: One woman was scheduled as a seminar speaker during FY 84. Dr. Christina Enroth-Cugell gave a seminar on "Cat retina ganglion cells."

Sixty-day temporary promotions to GS-6 editorial assistant were given to three White females. Two White females were detailed to GS-6 editorial assistant for 60 days. One White female was detailed to a GS-9 writer-editor position and one White female was detailed to a librarian GS-9 position for 60 days. A temporary promotion to GS-7 management assistant was given to a White female. These were women in dead-end positions.

Temporary appointment of three White females was extended. This included one GS-3 clerk-typist; one GS-9 librarian, part-time; and one GS-4 clerk-stenographer.

One White male was detailed to a GS-11 engineering technician position for two 60-day details.

Five White males were advanced including promotion to electronics technician GS-7; electrical engineer GS-13; physicist GS-12; mathematical statistican GS-11; engineering draftsman GS-7; and medical supply equipment illustrator GS-10.

Federal women's Program

USAARL has an active Federal Women's Program headed by a Federal Women's Program Manager (FWPM) and an alternate FWPM. This program provided information on employment, training, and recruitment opportunities to women employed at USAARL. The FWPM at USAARL is appointed by the Commander and serves as his staff advisor on matters affecting women. The FWPM is a collateral duty assignment.

The FWPM at USAARL also is a member of the Federal Women's Program Committee (FWPC) for the Commanding General, Fort Rucker, Alabama. This committee provides the Commanding General with advice and information regarding issues affecting the Federal Women's Program (FWP) and the female employees in the Fort Rucker work force, develops proposals for improvements in the FWP at Fort Rucker, and provides assistance in developing the installation's Affirmative Action Program.

Junior Fellowship Program

The Junior Fellow in the Scientific Information Center has continued her training and was promoted to library technician GS-1411-04. She transferred to Auburn University where she is maintaining high grades in her studies.

Mobilization Designee (MOBDES) Program

The USAARL MOBDES Program has 15 designee positions, including allied science officers, medical officers, aviators, and combat arms officers. Four of these positions were filled during FY 84 giving USAARL a total of eight positions designated. USAARL has candidates for an additional three positions that have not been confirmed.

Scientific seminars

USAARL sponsored 11 scientific seminars at the Laboratory facilities. These seminars were given by subject matter experts performing research in the areas that coincide with USAARL research efforts.

The following is a list of speakers, their topics, the dates of their seminars, and their Laboratory sponsors. Benefits included transfer of information, cross-training for the research staff, and interaction with the research staff on primary research efforts. The seminars were open to the public; numerous persons from the scientific community unrelated to the Laboratory attended these seminars.

Dr. M. M. Ayoub of Texas Technical University spoke on "Size and strength screening of personnel for assignment to job" on 17 February 1984. His sponsor was LTC Schopper.

Dr. Lionel C. Greene, Jr., of Lockheed Missiles and Space Company spoke on "Vestibular mechanisms involved in spatial observation" on 1 March 1984. His sponsor was LTC Schopper.

Dr. Robert M. Shapely of Rockefeller University spoke on "Contrast in vision" on 12 April 1984. His sponsor was Dr. Kirby.

Mr. Richard L. Chandler of the Federal Aviation Administration's Civilian Aeromedical Institute spoke on "Survival in aircraft and automobile accidents" on 26 April 1984. His sponsor was Mr. Haley.

Dr. Stuart M. Anstis of York University, Canada, spoke on "I thought I saw it move: On visual motor perception" on 27 April 1984. His sponsor was Dr. Behar.

Dr. Daniel D. Reneau, Jr., of Louisiana Technical University spoke on "Mathematical and experimental analysis of oxygen transport in the brain" on 3 May 1984. His sponsor was Dr. Knox.

Dr. Jeremy D. Finn of the State University of New York spoke on "A comparision of approaches to repeated measures of analysis of variance" on 24 May 1984. His sponsor was Dr. Siering.

Dr. John R. Harsh of the University of Southern Mississippi spoke on "Use of single case experimental design in applied research" on 8 June 1984. His sponsor was Mr. Simmons.

Dr. Jeremiah I. Nelson of New York University spoke on "Visual assessment with swept evoked potential techniques" on 10 July 1984. His sponosr was Dr. Harding.

Dr. Christina Enroth-Cugell of Northwestern University spoke on "Cat retinal ganglion cells" on 17 July 1984. Her sponsor was Dr. Harding.

Dr. John W. Melvin of the University of Michigan spoke on "The biomechanics of cervical spine injury due to head-crown impact" on 19 July 1984. His sponsor was Mr. Haley.

Scientific programs

USAARL scientific research encompasses four of USAMRDC's major research areas. They are: systems health hazard, hazards of mechanical forces, combat crew effectiveness, and soldier chemical warfare antidote. Under each of these research areas, USAARL has an established scientific program or programs. Such scientific programs involve one or more individual projects documented by a DD Form 1498. This is a convenient system for grouping the work USAARL does, and it makes easier the tracing of compliance with USAMRDC guidelines.

The research areas and the DD Form 1498 that pertain to them are:

Title	DA accession number	Program element task area, work unit
Systems health hazard area		
Physiology and psychophysics of information transfer in the visual system	DAOG 5999	6.11.02.A CB 283
Military acoustic hazards: Mechanisms of hearing loss	DAOB 6889	6.11.02.A CB 282
Hazards of mechanical forces research area		
Vibration hazards in combat aircraft and vehicles	DAOG 6100	6.27.77.A AD 132
Biomedical application and health hazard assessment of oxygen enrichment breathing systems	DAOG 0169	6.27.77.A AF 134
Research countermeasures for significant medical hazards in military systems	DAOG 0165	6.27.77.A AF 133

Title	DA accession number	Program element task area, work unit
Development of military/ ASTM standard method for rapid assessment of burn hazard	DAOH 0152	6.11.01.A 00 291
Development of techniques to monitor brain function of aviators during flight in Army fixed- and rotary-wing aircraft	DA30 0426	6.11.01.A 00 293
Aviation physiologic and epidemiologic database	DA30 6075	6.11.01.A 00 295
Biodynamics of life support equipment and personnel armor	DAOG 0167	6.27.77.A AG 131
Life support equipment crashworthiness evaluations	DA30 2870	6.27.77.A AG 138
Auditory effects of blast overpressure	DAOG 5998	6.27.77.A AA 136
Combat crew effectiveness research area		
Aeromedical research of operationally significant problems in the Army aviation environment	DAOG 0151	6.27.77.A BH 165
Visual performance research related to operational problems in Army aviation	DAOG 0156	6.27.77.A BH 162
Anthropometric criteria for Army aviators	DAOG 6102	6.27.77.A BH 166
Military visual problems: Assessment, mechanisms, and protection	DAOB 6893	6.27.77.A BG 164

Title	DA accession number	Program element task area, work unit
Artificial intelligence and robotics: Biomedical applications	DA30 4235	6.27.77.A BI 167
Soldier chemical warfare agent antidote research area		
Antidote and antidote/agents effects on the visual system	DAOG 8399	6.27.34.A AO 381
Aviator performance effects of chemical warfare antidotes and pretreatment therapies	DA30 4298	6.37.64.A AG 101

Systems health hazard research area

This basic research project area principally involves the development of the minimum biological and biomedical databases necessary and sufficient to protect personnel from hazards that are generated by Army systems, combat operations, and work environments. Research efforts are directed both towards physiological and biomedical technology bases which provide the foundation for the more applied USAARL research programs addressing military systems and operations presenting potential health hazards. Investigations in this program include (1) studies to provide quantitative information on the physiological processes and mechanisms subserving visual perception and (2) studies to determine the physiological mechanisms of auditory injury from noise.

Hazards of mechanical forces research data

Background: The development, fielding, and use of modernized Army weapons, along with new doctrine for combat operations, threaten to subject the modern soldier to forces and demands which exceed his biological limitations. For example, increased noise levels and exposure profiles for a broad range of weapons will place additional demands on the capability of the human ear to withstand high noise environments and still function adequately. New combat doctrine which places increased priority on night operations and target detection raises questions about the soldier's visual capabilities and effective procedures for maintaining and enhancing them.

The operational questions and problems which arise from new weaponry and doctrine require biomedical technologies and criteria for effective solutions. These technologies and criteria, in turn, demand sufficient biomedical databases to support applied efforts. In most cases, however, the required databases either are nonexistent or woefully inadequate. Consequently, the need for new biomedical data to support solutions to contemporary and future-oriented problems is substantial. USAARL's basic research program is designed to meet this need.

Obviously, future-oriented Army problems are critical in guiding the basic research program. However, not all of tomorrow's problems and questions are foreseen today. In order to maintain a scientific base capable of addressing unforeseen problems, a proportion of the basic research is nonproblem oriented in nature. This serves at least two primary purposes. First, it adds to our knowledge of basic biological principles; and second, it keeps our scientists abreast of current findings and thinking in biological sciences such that this knowledge may some day be applied to help and protect the individual soldier.

The generic goal of the basic research program is to provide biomedical databases, along with technical concepts, to support applied research and development efforts of the Laboratory. The applications for these databases include damage-risk criteria, medically valid design criteria, medical input to doctrine and tactics, and medically based technologies. Secondary goals of

the program are to maintain professional proficiency of the scientific staff and to identify new concepts and technologies developed elsewhere with potential value for Army applications.

Objectives: The primary objectives of this research program include developing animal models for the study of visual and auditory functions; providing a database on exposure-injury relationships for impulse and steady noise; providing quantitative information on the physiological processes and mechanisms which underlie visual perception; and developing and validating concepts for new methods, techniques, and instruments to assess sensory capabilities and degradations.

Progress: In the visual neuroscience program, research was completed which verified the usefulness and reliability of the "spatial bandwidth equalization" (SBE) technique (Wiley, et al., 1984). The technique, which was developed in this Laboratory, provides for rapid measure of contrast sensitivity and supratheshold contrast perception to spatial-temporal modulated patterns. The SBE technique requires approximately one-half of the time needed for traditonal measures of contrast sensitivity while still maintaining the same statistical reliability. A disadvantage of the technique is that measures obtained with flickering patterns fail to show increased sensitivity to low spatial frequencies. Using the SBE system to measure the perception of contrast above threshold verified previous studies showing the relative independence of spatial detail on contrast matches. With the increased attention to contrast sensitivity as predictor for pilot performance, the SBE or a similar technique may provide the rapid measures needed for testing pilot candidates.

The discovery last year (Harding, et al., 1983) of a pharmacological method of selectively reducing the responsivity of a spatial frequency channel in the visual system was verified this year (Harding, et al., In press) with a different cholinergic drug. Further, the spatial-temporal signature of the channel was determined. This information now allows us to evaluate individual neurons and classes of cells to possibly determine the neural subsets responsible for the perceptual loss.

A procedure for photographically demonstrating perceptual losses in the visual system following mild nerve agent and/or antidote exposure was analyzed. Mathematical formulations were derived which describe perceptual losses due to ocular and/or neural effects. Following further engineering developments, the procedure may provide a useful means of photographically demonstrating perceptual losses likely to occur in a chemical battlefield.

A protocol to investigate the effects of spectral content of impulse noise was prepared and approved. Data collection was initiated. Four experimental groups have been completed. Preliminary indications are that frequency of exposure energy has a large effect on auditory injury.

DD 1498: This work was conducted under the following Research and Technology Work Unit Summaries:

Physiology and psychophysics of information transfer in the visual system, DAOG 5999, 283.

Military acoustic hazards: Mechanisms of hearing loss, DAOB 6889, 282.

Contributing work: Two contract projects contributed to the research objectives of this program:

Evaluation of inner ears (chinchillas) for loss of sensory cells using a surface preparation histology technique.

Blast trauma: The effects upon hearing.

Sensory physiology program

Human health threats dealt with in the program include, but are not limited to, those which are: (1) built into weapon systems, (2) caused by or accompanying military operations, (3) generated during combat training, and (4) inherent to certain microenvironments. Examples include bone-degrading vibrations present in armored vehicles, heat stroke induced by wearing chemical protective suits in hot environments, and hearing loss attributable to artillery weapon noise. Effects within this project area focus on identification and quantification of the vibration and noise assaults experienced by military personnel, development of dose-response relationships for each assault, and development of injury prevention and health protection criteria and technologies.

Auditory effects of blast overpressure program

Background: Current Army weapons development efforts aimed at countering Warsaw Pact threat capabilities include improved artillery cannons, antitank rockets, and mortars. New artillery cannons and propellant charges are being developed to meet doctrinal requirements for enhanced delivery range, rapid rates of fire, and reduced weight for air mobility. Improved antitank rockets with high-energy propellants may be fired from reflective enclosures such as bunkers or covered foxholes. And, mortar technology is being advanced to achieve greater delivery ranges and rapid rates of fire. In each of these families of weapons, dangerously high levels of blast overpressure are a byproduct of advancing weapons technology.

The high levels of blast overpressure which will be commonplace on the modern battlefield pose potentially serious health hazards to soldier operators. Air-containing organs such as the ear are particularly susceptible to injury, with serious medical consequences possible. Hearing loss, even temporary, among troops using blast-producing weapons can degrade critical soldier-machine performance; endanger effective command, control, and communications; and disrupt critical combat tasks such as detection of the enemy during patrol missions. Hearing loss thus can endanger the soldier's capability to accomplish the combat mission. Further, permanent hearing loss is a cause for substantial disability compensation payments, even under peacetime conditions. The existing exposure limit for impulse noise (i.e., blast overpressure) is based on a grossly inadequate biomedical database and on a number of assumptions which have yet to be validated. The physical characteristics of the blast wave which are responsible for injury to the ear have not been completely identified, and the mechanisms of injury within the ear are understood only poorly. Consequently, improvements in protection technologies have been difficult to achieve.

The primary long-range goal of this research program is the development of a valid damage-risk criterion. A secondary long-range goal is the development of technology, approaches, and devices with potential for improved protection against blast-induced hearing loss. A significant short-range goal is the direct validation of the adequacy of state-of-the-art hearing protection devices for critical developmental systems.

Objectives: The major technical objectives include quantitative analysis of the physical characteristics of blast waves, development of laboratory impulse noise exposure capabilities where pressure wave characteristics can be systematically varied, and development and validation of mathematical models to assess the effects of protective devices on effective impulse noise exposure criteria. Further technical objectives include identification of susceptibility factors predisposing individuals to blast-induced hearing loss and development and validation of mathematical models for predicting blast-induced hearing loss.

Progress: A study of the impulse noise reduction by hearing protection devices was initiated. The protocol was prepared and approved. Data collection is in progress. A report of the development of a microprocessor-based audiometer was completed (USAARL Report No. 84-7).

Publications: Development of a microprocessor based audiometer for threshold shift studies, USAARL RPT 84-7.

DD 1498: The above work was conducted under the following Research and Technology Work Unit Summary:

Auditory effects of blast overpressure,
DAOG 5998, 136.

Contributing work: Work done under the following contracts contributed to the research objectives of this program:

Effects of hearing protection of human auditory localization.

Math modeling of the hearing process.

Airblast studies with animals and man.

Noise hazards of combat vehicles program

Background: As part of a large-scale modernization program, the Army is developing or fielding advanced design combat vehicles for a wide variety of battlefield applications. Combat doctrine being developed for the battlefield of the future calls for high-speed, lightweight, all-terrain (i.e., tracked) vehicles for fighting and transporting troops, and also for heavily armored, yet high-speed tanks with enhanced firepower. Also integral to the high-intensity battlefield of the future will be high-performance helicopters with advanced design features. Such hardware combinations will generate hazardous levels of both steady noise from engines, sprockets, rotor blades, and the like, and impulse noise from machine guns, cannons, missiles, etc.

Coupled with such advanced hardware will be the requirement for continuous combat operations. This will have the effect of exposing crewmembers to greatly extended periods of steady and impulse noise in a 24-hour period. It also will likely induce fatigue and dehydration in large numbers of troops.

Extended exposure to hazardous levels of steady and impulse noise, especially when combined with other stressors, will present a serious risk of temporary and permanent hearing loss. Both types of hearing loss can degrade combat effectiveness by impairing effective command, control, and communications; disrupting critical operator tasks; and degrading critical hearing-intensive combat activities. In addition, permanent hearing loss constitutes grounds for disability compensation.

The effective protection of troops from loss of hearing requires adequate hearing protection devices of all types. However, not all available hearing protective devices provide adequate protection. Rigorous evaluation of developmental and commerically available hearing protectors is required to insure adequate protection. Further, an effective hearing conservation program requires up-to-date epidemiologic data on the extent of hearing loss and the resulting impact among specific groups of Army personnel.

The primary goal of this research program is to assess the effectiveness of hearing protective and audio communication devices in order to minimize the incidence and severity of noise-induced hearing loss among Army personnel. Long-term goals

include (1) the development of improved technologies and approaches for hearing protection and audio communications and (2) the development of improved methodology for evaluation.

Objectives: The major technical objectives of this research program include measurement of sound-attenuating characteristics of passive and active hearing protective devices and communication headsets; determination of the suitability of selected devices for specific Army applications; assessment of the influence of user variables on protective effectiveness; development and evaluation of new concepts for improved hearing protection and audio communications; development and validation of improved laboratory and field techniques (e.g., physical ear method) for evaluation of hearing protective devices; development and validation of mathematical models for predicting suitability of hearing protective devices; assessment of attenuation characteristics on audiologic performance; and epidemiologic assessment of the extent of hearing loss and the associated impact among selected groups of Army personnel.

Progress: The effects on attenuation characteristics of the Integrated Helmet and Display Sighting System (IHADSS) caused by wearing the chemical/biological (CB) mask were evaluated. It was determined that a degradation of attenuation occurred in the frequency spectrum below 1000 Hz; however, the effect does not constitute a significant hearing hazard. A modification to the earphone retainer system in the IHADSS was evaluated for effect on attenuation and overall frequency response of the earphone/earcup element. The improved retainer system provides a more positive control of the earphone element while maintaining attenuation above the specification requirements.

The production models of the Helmet Compatible Communication/Aural Protective System (HCCAPS) were evaluated for compliance with contractual requirements in the area of sound attenuation and communication. The Type II through IV devices do not meet real-ear attenuation requirements for most of the frequencies below kHz. Further evaluations are being completed to determine if improvements in attenuation are feasible. The talk-through and communication systems should provide the user with a reasonable means of communication in most of the acoustic environments. The ability to communicate during worse-case noise conditions of the Bradley Fighting Vehicle may not be realized with this system.

A project was initiated to determine the effects of various hearing protectors on various types of impulse noise. The protectors varied from Type II earmuffs to helmets with hearing protection. The impulses were selected to simulate weapon systems such as towed howitzers, shoulder-fired missiles, small arms, and tanks. Data collection is in progress with an expected project completion in the fourth quarter, FY 85.

Several first article and first production SPH-4 and DH-132 helmets were evaluated to determine compliance with specifications. The evaluations revealed several shortcomings in the helmets which would have resulted in significant acoustic hazards if they had been issued to Army personnel.

A new prototype crushable earcup for use in the SPH-4 helmet is being evaluated to determine acoustical acceptability. Preliminary results indicate significant improvements in low-frequency attenuation, due to increased earcup volume, while maintaining mid- and high-frequency attenuation.

DD 1498: The above work has been conducted under the following Research and Technology Work Unit Summary:

Medical assessment of hearing protective devices, DAOB 6886, 135.

Contributing work: Work done under the following contracts and customer-funded projects contributed to this research program:

Effects of hearing protectors on human auditory localization.

Characteristics of the HCCAPS.

Crushable earcup development.

Impact biodynamics of crashworthiness and personnel armor program

Background: The inevitable result of man's use of vehicles throughout history has been impact injuries caused by crashes of vehicles. Since crashes cannot totally be eliminated, vehicles increasingly have been designed to be more "crashworthy." Airworthy sciences have been developing since World War II. Crashworthy improvements still are needed in aircraft as revealed by statistics showing fatality rates little improved in the past 20 years. The performance of existing life support equipment in aircraft must be known prior to stating new crashworthy design criteria. Once the hazards are identified, methods to eliminate them can be developed.

In the past, USAARL primarily has been involved in the analysis of injuries seen in aircraft accidents under the auspices of the Aviation Life Support Equipment Retrieval Program (ALSERP), in which all equipment involved in the cause or mitigation of injury is sent to USAARL. In the past 3 years, however, the scope of impact-related work has been expanded to include parachute "impact" in high airspeed jumps, chest armor "impact" from .50-caliber bullet defeat, tank gunner brow pad "impacts," and motorcycle helmet "impacts."

Objective: To identify impact injury mechanisms of US Army fliers via standard epidemiological techniques, and to correlate injury with the input energy so that design and test criteria may be provided for helmets, restraint systems, parachutes, and personnel-armor loading.

Progress: Since last year's report, several more UH-60 crashes have occurred which demonstrated the enhanced crashworthy performance of this aircraft. The pilot seats provided a "load-limiting" stroke of the seat toward the floor in two crashes; and no back injuries were sustained by a lightweight female occupant, but a 49-year-old male occupant did sustain an anterior fracture of L1 vertebra. The lack of back injury to seven of eight occupants in four severe (high sink rate) crashes in the past 3 years tends to verify the fact that the 14.5 G "load limit" level is not too high as had been predicted, as based on cadaver impact tests. On the other hand, the collapse of the UH-60 roof in high sink rate crashes is disappointing and

a cause for concern if a crash occurs a full load of troops. The UH-60 troop seat tie-down strength also is inadequate, but the problem has been recognized and USAARL hosted a conference on this specific topic on 7 September 1984. The conferees agreed that some action towards a strengthened troop seat would be initiated by directive from the Army to Sikorsky.

The planned continuation of the UH-60 pilot seat comparative tests at the Civil Aeromedical Institute (CAMI) were delayed due to several administrative problems; the seats now are scheduled for testing in the first quarter, FY 85. Plans also were made to request an outside biomedical expert to analyze the UH-60 seat test results and provide a report based on input from all of the agencies involved in the tests.

The US Navy-sponsored helmet retention tests were completed in the second quarter, FY 84; however, the analysis of the results and the report have been delayed. The report currently is in rough draft form.

The Human Engineering Laboratory (HEL)-sponsored tank gunner brow pad impact test results were anyalzed and a draft report completed.

The Test and Evaluation Command (TECOM) high-speed parachute tests with USAARL-instrumented dummies have been delayed indefinitely. USAARL will monitor the tests when rescheduled.

Continued support was provided to the US Army Aviation Systems Command (AVSCOM) for development of the HGU-56 integrated flight helmet. USAARL participated in all quarterly reviews and also hosted two contractor visits to check the compatibility of the helmet with all cockpit systems. The final configuration of the helmet has been selected and prototypes are scheduled for delivery in the first quarter, FY 85.

Technical representatives were provided for the Source Selection Evaluation Board (SSEB) for the US Army motorcyclist helmet. A motorcycle helmet contract has been awarded and prototypes are scheduled for delivery to USAARL for evaluation in the second quarter, FY 85.

USAARL's physical testing capability was improved significantly with the installation of a 10,000-pound, 11 m/s impact test machine with a 0.4 m stroke. The effects of stress concentration on webbing is planned for evaluation on this machine.

A ballistic test facility with .50-caliber size capacity was completed. The facility can be used to evaluate the effects of missile impact on the Army's life support equipment.

Publications: Anthropometric cockpit compatibility assessment of US Army aircraft for large and small personnel wearing a training, warm-weather clothing configuration, USAARL RPT 84-10.

Anthropometric cockpit compatibility assessment of US Army aircraft for large and small personnel wearing a cold-weather, armored vest, chemical defense protective clothing configuration, USAARL RPT 84-11.

Presentations: "Foot-loading tracking behavior: An initial evaluation," presented to the International Ergonomics Association, April 1984.

"Task interaction on a force loaded pursuit rotor," presented to the American Psychological Association, August 1984.

DD 1498: The above work was conducted under the following Research and Technology Work Unit Summaries:

Life support equipment crashworthiness evaluations, DA30 2870, 138.

Biodynamics of life support equipment and personnel armor, DAOG 0167, 131.

Vibration hazards of combat vehicles program

Background: This program was initiated to study the effects of vibration on musculoskeletal disorders in Army aviators. Since unique vibration exposures are present in each emerging vehicular weapon system, the program has been expanded to cover all types of vehicles. The long-term goal of the vibration program is the development of vibration tolerance limits as a function of amplitude, frequency, and exposure time for use as criteria for vehicle development.

Objective: To conduct multidisciplinary basic and applied biomedical engineering to (1) record and characterize the field environment of vibration, (2) duplicate the field environment in the laboratory to study effects on human health and performance, (3) develop scientific database of pertinent medical and performance-related information, (4) determine short-term and cumulative biomedical effects of vibration on the musculoskeletal system and develop technologies which reduce these effects, and (5) evaluate and develop medical and performance-based criteria on human vibration tolerance.

Progress: Data collected from an epidemiological questionnaire study designed to assess the prevalence of low back pain among US Army aviators was analyzed. A draft report has been written and submitted for review. Trends indicated that low back pain may be affected by helicopter seating posture.

A report titled "Helicopter pilot back pain: A preliminary study" was published in Aviation, Space, and Environmental Medicine (February 1984) by Shanahan and Reading. The report compared onset time and intensity of low back pain (LBP) experienced by a group of 11 aviators. The subjects compared LBP experienced as a result of sitting in the same seat while exposed to whole-body vibration. Preliminary results implicate poor posture as a possible cause for aviator LBP.

Work under a Wright State University contract confirmed that isometric strength of neck muscles is significantly less in the lateral mode than in flexion or extension. Amplitude of surface electromyographic (EMG) signals showed continuous increases for fatiguing contractions, while the center frequency for the EMG

power spectrum continuously decreased. A pronounced increase in both blood pressure and heart rate was observed during isometric contractions of the neck muscles. A piece-wise linear analysis mathematical model has been developed which will predict neck muscle isometric endurance times for various helmet weights and centers-of-gravity within the experimental boundary conditions. In addition, a statistics package was developed which was specifically tailored to this math model. The package shows the statistical significance of the results of predictions made using the math model.

Work has begun to assess the effects of helmet weight and center-of-gravity on head tracking ability and neck-muscle fatigue while exposed to whole-body vibration. The preliminary data suggests that y-axis (left/right) vibrations have little effect on tracking ability regardless of the helmet weight and center-of-gravity. Z-axis (up/down) and x-axis (fore/aft) vibrations produce the greatest amount of tracking error. Vibration exposure duration, center-of-gravity eccentricity, and helmet weight play major roles in the development of neck muscle fatigue and resultant tracking-error effects.

Under a University of Vermont contract, work began which will attempt to establish the relationships between vibration, posture, and possible causes of low back pain in Army rotary-wing aviators. EMG response of the lower back musculature was monitored while volunteers maintained a standard aviator posture in a nonvibrating environment. Root-mean-square (RMS) amplitude of the EMG power spectrum decreased as the back muscle became fatigued. Static testing was completed. Single-axis vibration testing of each of the three axes also was completed, but the accumulated data still is being reduced. Preliminary analysis indicates that posture of the rotary-wing aviator may play a significant role in low back pain.

Publications: "Helicopter pilot back pain: A preliminary study," Aviation, Space, and Environmental Medicine, February 1984.

DD 1498: The above work was conducted under the following Research and Technology Work Unit Summary:

Vibration hazards of combat aircraft and vehicles, DAOG 6100, 132.

Contributing work: Work conducted under the following contracts contributed to the research objectives of this program:

Neck muscle endurance as a function of helmet loading: The definitive mathematical model.

The effects of helicopter vibration on the spinal system.

Crew life support systems biotechnology program

Background: Modern warfare is predicated on the use of an ever-increasing variety of technologically advanced weapons, transport, and communication systems. Couple this trend with doctrine which emphasizes round-the-clock sustained operations and there exists the potential for a devastating conflict. On the one hand, advanced technology and new tactics give our troops an edge in any potential battle. On the other hand, man's inherent physiological, and perhaps psychological, limitations can neutralize totally any such advantage. The crew life support systems biotechnology program is designed to identify, evaluate, and eliminate or prevent the health hazards resulting from the mismatch between the soldiers' physiologic needs and the environment resulting from the use of new equipment, weapons, and tactics.

Specifically, current focus is on maintaining aviators in the proper state of oxygenation under all flight conditions and on minimizing the deleterious effects of wearing chemical protective ensembles while conducting aviation operations and training. Short-range goals are (1) to evaluate the concept of using pressure swing molecular-sieve technology to produce clean, breathable, oxygen-enriched air to alleviate all levels of hypoxia, and (2) to evaluate current and proposed chemical defense ensembles in the flight environment to ascertain how long aviators can fly effectively without succumbing to heat stress or other stressors imposed by these basically cumbersome protective systems. Long-range goals call for collection of extensive databases relating physiologic response to environmental stressors from which computer models can be developed which will assist in optimizing life support systems design.

Objective: The crew life support systems biotechnology program is designed to identify, assess, and prevent unnecessary health hazards imposed by exposure to the operational environment, toxic gases, varying oxygen levels, chemical and biological agents, and antidotes or other drugs; to provide the Army technical information, recommendations, and standards to be used in the development and modification of systems that provide protection from those hazards; and to develop a database identifying and quantifying the physiological and medical impact of life support equipment on mission accomplishment. This

program also is designed to identify and elucidate problems associated with life support equipment and to develop computer models based on analytic and empirical data to facilitate the conceptualization and development of design criteria for improved life support equipment.

Progress: The study titled "Heat stress effects of the aircrew chemical defense ensemble" was conducted with a report due to be completed by early FY 85. A study titled "Aviator performance effects of chemical warfare antidotes" will proceed in early FY 85. Joint work on heat stress with Dr. Nunneley of the USAF School of Aerospace Medicine was initiated.

Team members continue to participate in the process to develop and test new aviation life support equipment for use on the integrated battlefield.

The cardiopulmonary research program moved ahead with a final report on computerized pulmonary function tests on over 200 active duty Army aviators. The cardiopulmonary stress lab was upgraded and made ready for a planned extensive effort to build a database on Army aviation physiology. This cardiopulmonary database is being established to assist in longitudinal studies of effects of stress and to help in design of life support equipment.

Computer modeling progressed with the BRNSIM burn prediction model implemented on two additional computers, PDP 11/24 and DEC VAX 780. A large parametric study from the University of Rochester was simulated with reasonable results. Discussions were held with the staffs of Natick Laboratories, Naval Air Development Center, the USAF School of Aerospace Medicine, and the University of Texas regarding use of BRNSIM and its possible extension to predicting laser burns.

A study was initiated to develop techniques to measure evoked responses in aviators while they pilot simulators and aircraft. Equipment was ordered and received. Several hours of EEG recordings were made from subjects riding in vehicles and rotary-wing aircraft. These techniques will be expanded to recording of evoked responses.

The biochemistry laboratory was enhanced in preparation for studies of aviator stress and effects of antidotes on performance. This effort will continue in FY 85. Experimental efforts and math modeling on chemical fiber properties of OBOGS were set up to start in FY 85.

Tri-Service life support equipment retrieval program

Background: USAARL conducts a tri-service life support equipment retrieval system (LSFRP) which brings crash-damaged helmets, seats, and flight clothing to our facility for analysis and study. Helmets are the items most often received from the Air Force and Navy.

Army aviation life support equipment involved in either injury causation or prevention in the field is sent to USAARL for biomedical and injury correlation evaluation. The evaluation assesses the effectiveness of life support equipment through an integrated analysis of the physical condition of the protection devices, the human injury incurred, and the related human dynamics involved in the accident.

Objectives: Data collected through the LSERP helps identify hazard protection deficiencies associated with the equipment. Also, these data enable USAARL to provide injury-reducing design recommendations and health criteria for the improvement of life support equipment.

Progress: During FY 84 the retrieval program was expanded to include the analysis of ground vehicle personal protection equipment. On two occasions, the US Army Safety Center had requested and received timely analysis in this area.

Data collection in the program has been the basis for the report "SPH-4 US Army flight helmet performance 1972-1983" which is now in the final editing.

The next generation flight helmet (HGU-56P) is in the prototype stage and much of the improved protection in the helmet shell and styrofoam liner as well as the improved maxilla protection and the crushable energy attenuating earcup found in this helmet can be directly attributed to the findings of the studies on the helmets received in this program.

Inputs related to the proposed aircrewman's survival recovery vest currently are addressing concerns which surfaced in the ALSERP files.

DD 1498: The above work was conducted under the following Research and Technology Work Unit Summary:

Biodynamics of life support equipment
and personnel armor, DAOG 0167, 131.

Combat crew effectiveness research area

This project area encompasses research programs which are directed toward the delineation and study of behavioral, psychological, physiological, and performance requirements imposed by military operations, environments, and special equipment. The purpose of this work is to prevent casualties by assessing factors which serve to increase the soldier's vulnerability to the stressors of a combat environment. Inadequate training, indoctrination, physical conditioning, as well as high stress loads imposed by the rigors of the combat environment, all potentially impact on the soldier during operational missions. Further factors, such as excessive heat and cold and complex and sustained work requirements, may overload the soldier and exceed human tolerance in life-threatening situations. Physiological and psychological investigations are conducted to identify environmental and operational stressors, and to provide data on the cost/payoff relationship between such stressors as soldier tolerance, sustained ability, and survivability.

Effects include, but are not limited to, visual capabilities and limitations; medical indexes of crew workload and fatigue; soldier selection and physical fitness; and biomedical aspects of environmental factors on human functioning as well as those soldier factors affecting performance and survivability under conditions of sustained and chemical operations.

Sensory limitations of man/machine systems program

Background: The extreme lethality of the modern mid-to-high-intensity battlefield is forcing changes in tactics, weapons, and personal protective equipment. Advancing weapons technology, along with doctrinal requirements for continuous operations (including nighttime operations), combine to produce stresses which threaten to exceed the capabilities and limitations of the human operator and thereby degrade crew performance. For example, the visual demands of night vision goggle flight may necessitate new visual selection and retention criteria, and the requirement for continuous operations may exceed the soldier's visual performance capabilities after extended periods of operation. The use of protective devices such as laser goggles; sun, wind, and dust goggles; and helmet visors threatens to disrupt the crewmember's visual performance.

The doctrinal requirement for around-the-clock combat operations results in special concerns about the human operator's capabilities to function effectively in darkness. Red lighting has been used in Army aircraft cockpits since pre-World War II days because of its ability to preserve nighttime visual sensitivity. However, in future aircraft, blue-green lighting will be required in order to achieve compatibility with aviator night vision goggles. This may compromise flight capabilities with unaided vision. The existing biomedical database regarding the visual performance effects of vibration, darkness, night vision goggles, protective goggles, and similar stressors is inadequate for countering the potential threats to combat effectiveness. The nature, extent, and mechanisms of visual performance degradation largely are undefined, and the resulting impact on combat effectiveness has not been determined.

The overall goal of this research program is the development of realistic measures to prevent compromised combat effectiveness due to impaired visual performance. These preventive measures will include exposure criteria and modified operational doctrine. A major intermediate goal is the establishment of a visual effects biomedical database sufficient to support development of such measures.

Objective: The major technical objectives of this research program include identification of the parameters of visual functioning which are degraded by vibration, darkness, body position, protective devices, night vision goggles, fatigue, and spectral characteristics of lighting. Characterization and quantification of visual degradations produced by specific stress factors, identification and characterization of the relationships between identified visual degradations and task performance, and development and validation of models for predicting the impact of specific visual degradations on combat effectiveness are major technical objectives. Also included as objectives are development and validation of exposure criteria and/or materiel design criteria for selected stress factors, development and validation of selection/retention criteria and operational preventive measures for selected stress factors, and development of instrumentation for rapid, reliable measurement of selected visual performance parameters.

Progress: The role of aviation in US Army operations at night greatly has been enhanced by the wide use of the AN/PVS-5 and the soon-to-be introduced AN/AVS-6 night vision goggles. Each of these goggles utilizes tubes containing optics and electronics positioned directly in line with each eye. These tubes have the potential for displacement upon impact. For those aviators wearing corrective lenses, the tubes represent a possible hazard. Studies of the relative impact-resistance of glass, plastic (CR-39), and polycarbonate ophthalmic lenses show the latter affords many times more protection. This has been further confirmed by a study using actual night vision goggles and determining the forces necessary to cause glass lens breakage. Currently, only glass lenses can be issued to aviators. An effort is being made to replace these glass lenses with polycarbonate for the aviator required to fly with the goggles.

As part of an overall program designed to review and validate the tests and criteria currently applied to vision standards for aviators, a contact lens study has been initiated. This study primarily addresses the feasibility of extended-wear contact lenses as a means of resolving interface problems with new electro-optical devices. Interest in this new family of contact lenses also has come from ground combat commanders and has led to a planned study to be conducted at Fort Hood, Texas. The purpose of the study will be to determine how well the lenses function psychophysiologically for ground troops and to establish what effect, if any, they have upon individual duty performance. To better accommodate research directed to the application of contact lenses in the military, a type protocol has been written and currently is being staffed. Each of the above studies, plus others planned at different locations, will be conducted under this approved protocol. This document will be augmented by the addition of information unique to each particular study.

International coordination and standardization continues to be accomplished through active participation in the Air Standardization Coordinating Committee, Working Party 61, Aviation Medicine and Life Support Systems.

The range of acceptable levels of haze in military specifications for optical transparencies is at least 12-to-1 for different material and appears not to be dictated by the vision requirements of the transparency user. To determine the visual performance effects of transparency haze, the visual contrast sensitivity function was measured with transparencies of 0.5 to 20 percent haze, both with and without glare. Contrast sensitivity research continues with an evaluation of cycloplegia effects on visual performance.

Optical testing was conducted on the IHADSS visor, AH-64 CB protective mask, two candidates for the XM-40 protective mask, the US-10 respirator mask, and the Ordnance Bomb Disposal Faceshield.

The field-of-view (FOV) of the IHADSS helmet display unit was measured with a modified spectacle. Losses of FOV were negligible.

An electronic, automatic gain control circuit was designed for video imaging of dynamic light levels.

Publications:

Automatic gain control circuit for video signals of scenes of varying illumination levels, USAARL RPT 84-9.

Head movements during contour pilotage, USAARL RPT (In press).

Light level calendars of lunar illumination at Fort Rucker, Alabama, for January-June 1984, USAARL LR 84-1-2-1.

Light level calendars of lunar illumination at Fort Rucker, Alabama, for July-December 1984, USAARL LR 84-6-2-2.

Visual, optical, and accoustical evaluations of the AH-64 CB protective mask, USAARL LR (In press).

Protective item testing of the display and cockpit design options for the light helicopter family (LHX), USAARL LR (In press).

Presentations: "Investigating elementary decisions and attribute level processing in preferential choice: A combination of normative and descriptive analyses," presented to the Southern Society for Philosophy and Psychology, Columbia, South Carolina, April 1984. (Griffith Award for Outstanding Paper receipient)

"The effects of different tear solutions on the corneal epithelium," presented to the American Academy of Optometry, Houston, Texas, December 1983.

"US Army aeromedical update," presented to the Biannual AMEDD Professional Postgraduate Short-course in Military Optometry, Fitzsimmons Army Medical Center, Aurora, Colorado, August 1984.

DD 1498: The above work was conducted under the following Research and Technology Work Unit Summary:

Military visual problems: Assessment, mechanisms, and protection, DAOB 6893, 164.

Biomedical aspects of crew workload, staffing and selection program

Background: Identifying, defining, and quantifying man's physical requirements, task demands, and biomedical limitations associated with various systems and technology become critical for the optimal design of equipment, prediction of performance criteria, and development of biomedical models. Military developers, planners, and specialists at every level must be aware of the unique hazards generated by Army systems and technology, and that these hazards further are elevated by the adverse environment of the Army tactical operations in which the soldier is required to function.

Army aviation, with its highly sophisticated airborne systems, represents a prime example of a military operational area that lacks complete parametric research to develop empirical criteria for ideal man-machine interface and analytical tolerance/survivability/capability envelopes within which the selected aircrew will be forced to work and endure. A more complete biometric database is not available to describe and quantify pilots' stressors, military hardware, advanced tactics, and progressive military operations.

USAARL's research program is designed to establish/update aircrew selection criteria; evaluate requirements for optimum man-machine interface; and provide physiological and psychological guidelines describing and quantifying tolerance, survivability, and capability envelopes of man within the military flight environment. The long-range goals of this research are to establish extensive biomedical databases and predictive models to reduce or eliminate aviators' impaired performance; sensory, cognitive, and physical overload; combat stresses; and, in general, hazards inherent in Army systems and in the Army environment.

Objective: The objective of this research program is to develop standards for aeromedical hazard definition and to postulate hazard definitions based upon field assessment of combat operations, including systems and environmental effects.

Extension of the database regarding the visual performance/workload of fixed- and rotary-wing aircraft aviators during varying tactical missions with special emphasis on the quantification and interpretation of these data, on their relation to variables, such as pilot physiological and psychological states, and on task loading comprises a second objective of this program. Further efforts include determining decision requirements/processing limitations of man and developing predictive models identifying cognitive capabilities and overload criteria incurred by highly sophisticated aircraft technology within a combat environment, defining and quantifying aviator pyschomotor processes with the biomedical parameters affecting aviation personnel during sustained military operations.

Progress: Research efforts have continued toward cognitive workload and psychological measurements. During a heat stress study conducted this past summer, the psychological assessment battery (PAB) was administered in a field setting. Aviators took the PAB while in complete MOPP IV equipment. Another instrument utilized during the heat stress study was the zero input tracking analyzer (ZITA), which presents several qualitatively different types of tracking tasks, as well as some auditory distraction tasks. The ZITA also was administered in a field setting with the subjects wearing MOPP IV equipment. Both the PAB and ZITA data currently are being analyzed. Other types of pilot performance data, as recorded by the helicopter in-flight monitoring system (HIMS), also is being analyzed.

Considerable effort recently has been invested in having the capability to better medically monitor subjects that are participating in potentially stressful environments, such as heat. A system currently is being utilized that involves video telemetry that may greatly enhance monitoring capabilities. A report on this new capability is forthcoming.

Research design for both psychological and physiological efforts of chemical warfare antidotes continues to be a high priority. This study is expected to begin early next fiscal year and continue throughout the year. Equipment procurement and modifications almost are complete.

Publications: Effects of extended use of AN/PVS-5 night vision goggles on helicopter pilot's performance, USAARL RPT 84-3.

Assessment of stress descriptor for aeromedical research, USAARL LR 84-2-3-1.

Concept evaluation of Bell Helicopter-Textron micro-heads-up display for night vision goggles, USAARL LR 84-5-3-4.

Presentations: "Psychological effects of the chemical defense ensemble," presented to the American Psychological Association, August 1984.

"Measurement and interpretation of eye movements," presented to Human Factors Society, October 1983.

DD 1498: The above work was conducted under the following Research and Technology Work Unit Summaries:

Aeromedical research of operationally significant problems in the Army aviation environment, DAOG 0151, 165.

Visual performance research related to operational problems in Army aviation, DAOG 0156, 162.

Research directed at biomedical parameters affecting aircrew workload during sustained operations, DAOG 0153, 161.

Artificial intelligence and robotics: Biomedical applications, DA30 4235, 167

Contributing work: Work conducted under the following customer-funded project contributed to the objectives of this program:

Work conducted under a Letter of Agreement with the US Marine Corps and the US Aviation Center, Directorate of Combat Developments, Fort Rucker, Alabama, 21 November 1980, subject: Letter of Agreement: Joint service research on night vision goggles subminiature displays.

Anthropometry and ergonomics program: Criteria for Army aviators

Background: With the emphasis upon incorporating females into the US Army, there came the increasing realization that empirically based criteria to guide the selection of personnel did not exist. For those seeking entrance into the Army aviation program, the criteria traditionally have been based on the 5th-95th percentile male. To rectify this circumstance, the Laboratory embarked upon a major research effort to develop empirically based selection standards to assure that an effective aviator-cockpit interface exists for each of the aircraft in the present Army inventory.

The program consists of five separate subtopics: (a) a physical determination of aircraft cockpit reach-related requirements; (b) a determination of actual, cockpit-referenced eye positions of rated Army aviators for the Army's principal rotary-wing aircraft; (c) a determination of the in-flight control force requirements which exist during "hydraulics off" emergency landing maneuvers; (d) a determination of helicopter-control-related physical forces exertion capabilities; and (e) an evaluation of the effects of variation in the level of control force resistance upon performance as a function of subject strength.

Objective: The objective is to establish anthropometric size and strength criteria for Army aviators.

Progress: Two laboratory technical reports were published which described findings pertinent to the physical dimensions required to functionally reach all critical controls in US Army aircraft: USAARL Report No. 84-10, Anthropometric cockpit compatibility assessment of US Army aircraft for large and small personnel wearing a training, warm-weather clothing configuration (Schopper and Cote, 1984) and USAARL Report No. 84-11, Anthropometric cockpit compatibility assessment of US Army aircraft for large and small personnel wearing a cold-weather, armored vest, chemical defense protective clothing configuration (Cote and Schopper, 1984). Data analysis continued regarding assessment of helicopter-control-referenced physical force exertion capabilities. Preliminary findings were reported during

the 1984 International Ergonomics Society Conference and subsequently published in the proceedings: "Helicopter controls: Effects of gender and stature on control force exertion," (Schopper and Mastroianni, 1984). Description of the degrading effects of elevated control-force requirements upon performance of subjects simultaneously engaged in the performance of an elementary visuomotor tracking task and an auditory-memory task was presented during the Annual Conference of the American Psychological Association: "Task interaction on a force-loaded pursuit rotor," (Mastroianni and Schopper, 1984). Data analysis continued during the year in support of the preparation of technical reports pertaining to remaining areas of work addressed in this research program.

DD 1498: The above work was conducted under the following Research and Technology Work Unit Summary:

Anthropometric criteria for Army aviators,
DAOG 6102, 166.

Soldier chemical warfare agent antidote research area

The overall objective of this program area is establishment of the visual effects database required to develop safe and efficacious prophylaxes, pretreatment compounds, antidotes, and therapeutics necessary to assure individual protection, rapid return to duty, and militarily effective soldier performance on a chemical warfare (CW) battlefield. This will require development of (a) medical concepts and technologies; (b) pharmacologic material; and (c) resources and systems for prevention, treatment, and management of CW agent casualties. Emphasis is placed on development of antidotes that will assure soldier protection against nerve agents while preserving visual capabilities necessary to maintain combat effectivness.

Antidote and antidote agent effects on the visual system program

Background: The chemical warfare (CW) capabilities of the Warsaw Pact nations pose a real threat for potential mass casualties that would at the very least compromise unit effectiveness. Serious deficiencies in the existing protective capabilities include the lack of CW agent prophylaxes, an incomplete spectrum of antidotes, and antidotes with operationally compromising side-effects. The urgent DOD requirement to develop prophylaxes, pretreatment compounds and antidotes, and the necessary concepts for their use in the medical management of CW casualties cannot be accomplished through the utilization of currently available information and technology. We do not know the mechanisms of action for the current CW agents, their suspected antidotes, or possible prophylactic compounds, or combinations of the three.

CW agents, especially the nerve agents (organophosphates), have diverse toxic effects on both the central and peripheral nervous systems. Many of the central and peripheral toxicities consist of disruptions of neural functions related to the action of organophosphates on neural transmission in the cholinergic system, where acetylcholine is the known neurotransmitter. We know that acetylcholine is important in control of pupil size as well as the processing of visual information by the retina. It also may be important at more central visual locations. However, neurotransmitters other than acetylcholine also may be involved and contribute to organophosphate-induced neurotoxicity.

In any battlefield situation, a soldier's capability to perform visual tasks is critical for completion of the mission. With widespread use of CW agents, the survival of the unit, as well as the individual, may depend on visual capabilities. Consequently, the Army's efforts to develop antidotes, pretreatments, and prophylactics require valid information on the effects of these compounds on visual functions. The primary objective of this research program is to develop a comprehensive

biomedical database on the efforts of selected nerve agents, candidate antidotes, possible prophylactic compounds, or combinations of the three on the retina and higher visual centers. Animal models will be selected or developed to enable inferences regarding effects on the human visual system of various agent/antidote/prophylactic compound combinations. Methods will be developed to predict how well a soldier will be able to visually complete his mission following a specified exposure.

Objective: The following technical objectives are required to achieve the program's goals:

1. Characterization of the effects of nerve agents and/or their antidotes or pretreatments on retinal functions by means of acute and chronic animal experiments utilizing neurophysiological techniques. The retinal functions to be evaluated include: light/dark adaptation, relative sensitivities across classes of retinal neurons, spatial-temporal contrast sensitivities, stimulus-response relationships, receptive field properties, and spontaneous activity.

2. Quantification of transmission loss along the visual pathway with gross potential neurophysiological recording techniques and assessment of performance loss due to drug exposure.

3. Assessment of cholinergic system interactions with other transmitters in the visual system following drug administration.

4. Identification of sites of action and uptake of antidotes and agents within the visual system by means of autoradiography to provide additional information as to the mechanisms of action and the possible occurrence of local pooling of nerve agent.

5. Comparison of single cell data with gross potential and anatomical findings to provide an overall picture of visual system function following antidote/agent insult.

6. Development of models and techniques to predict impact on human visual performance and combat effectiveness.

Progress: Experiments assessing the effect of carbamates and organophosphates on the cortical visual evoked response (VER) in cats has been conducted. Both physostigmine and diisopropyl fluorophosphate (DFP) produced a marked decrement in the VER. In each case, there was a preferential reduction of the response to low spatial frequencies while responses to higher spatial

frequencies were affected minimally. EEG amplitude and blood acetylcholinesterase (AChE) levels were depressed by both drugs. The visual loss in both cases was at least somewhat dose dependent and could be reversed by atropine. The reduction of the VER is greater with physostigmine than with DFP, although there is more AChE inhibition with DFP. This is consistent with the works of others which shows a direct effect of physostigmine on ionic channels in nerve membrane. In addition, the visual loss following anticholinesterase agents is linked more closely to AChE activity than pseudocholinestrase activity, even though the distribution of the two rival each other in the central visual pathway.

The maximum effect of physostigmine is recorded immediately after its administration; while the DFP effect is slower to develop, reaching its maximum in the first 2 hours. Although DFP is an irreversible inhibitor of AChE, slow spontaneous recovery of the VER to base line levels occurs within 20 hours even though there is no recovery in enzyme activity. This suggests the involvement of mechanisms in addition to the accumulation of acetylcholine (ACh). Preliminary receptor binding studies and those using selective synaptic antagonists suggest that gamma-aminobutyric acid may be involved.

Since atropine provides partial recovery of the VER, an accumulation of ACh likely is involved in the initial visual loss. Small doses of DFP, resulting in relatively low cholinesterase inhibition, often lead to slight enhancement of the VER across all spatial frequencies. This supports the strong suggestions in the literature that cholinergic fibers may play a role in the mechanisms of arousal.

Finally, analysis of earlier data and new preliminary studies have suggested that a substantial number of experimental animals may have their normal AChE levels depressed by halothane anesthesia. This is a critical factor to determine before encountering a nerve agent on the battlefield where casualties requiring surgery already may have depressed levels of AChE.

DD 1498: This work was conducted under the following Research and Technology Work Unit Summary:

Antidote and antidote/agents effects
on the visual system, DAOG 8399, 381.

Effects of chemical defense antidotes and pretreatment therapies on aviator performance program

Background: Army aviation is at serious risk in chemical and biological warfare environments. Even nonlethal riot agents such as tear gas will hamper the ability of aviators to maintain control of their aircraft. Thus, in real terms, should unprepared aviators encounter a chemical agent in aerosol form (or any form), the potential outcome is the loss of the aircrew and aircraft and the failure of the mission. While crews and passengers could conceivably don protective gear as needed in flight, it would be very difficult for aviators to neglect their flight tasks to don a chemical defense (CD) ensemble in the cockpit. Therefore, in any chemical threat situation, aviators must don the CD ensemble prior to entering the cockpit. Thus, the ability of the pilot to effectively operate his aircraft while in a CD ensemble is the first requirement for operational effectiveness on the chemically contaminated battlefield.

The second key to effective operation in a chemical environment is the development of antidote and pretreatment drugs, which at a minimum will allow safe return of the crew and aircraft. The ideal compounds which would allow efficient mission accomplishment even after exposure have not been confirmed safe for implementation into the aviator environment. Three compounds, atropine sulfate, pralidoxime chloride (2 PAM-CL), and pyridostigmine, are currently under consideration as chemical warfare antidotes and pretreatment drugs. There are, however, only a few limited studies which address the ability of aviators to fly helicopters after having taken these drugs. Each drug has side effects which suggest 'a priori' that effective mission accomplishment or safe flight may not be possible after receiving the normal doctrinal dose of these drugs. Thus, the need to determine the performance effects of antidote and pretreatment drugs is driven by the requirement for Army aviators to survive and maintain combat effectiveness on the chemically contaminated battlefield. More specifically the question becomes, if an aviator self-injects an antidote while flying in a hostile environment, will he be able to return to a safe area of operation; and will he be able to carry out other missions before fully recovering from the antidotes?

Objective: Recent intelligence and published changes in Warsaw Pact Military Doctrine have significantly enhanced the probability that the enemy will use chemical and biological agents during the next war. The objective of this program is to exercise a simulated flight and in-flight research program that will assess the performance of Army aviators who are voluntarily administered chemical warfare antidotes and pretreatment therapeutic drugs (ADP). This research program will determine through objective performance measurements the effects of these drugs on the efficiency of aviators while accomplishing flight tasks required by operational scenarious.

Progress: An extensive protocol covering this entire effort has been finalized and approved locally and by The Surgeon General. Phase I of the effort has been reviewed and approved by the Department of Defense Human Use Committee. Recruitment of volunteer aviators for Phase I has been accomplished and data collection is scheduled for second quarter, FY 85.

DD 1498: This work was conducted under the following Research and Technology Work Unit Summary:

> Aviator performance effects of chemical warfare antidotes and pretreatment therapies, DA30 4298, 101.

Technical participation

Air Standardization Coordinating Committee (ASCC) Working Party 61

The Air Standardization Coordinating Committee (ASCC) Working Party 61 is a chartered international military organization of English-speaking nations which addresses aerospace medicine and life support. Emphasis is placed upon standardization, interoperability, and technology exchange. Member nations include the United States, Canada, the United Kingdom, Australia, and New Zealand. USAARL provides technical consultants and a principal committee representative to actively participate in the committee's activities and to coordinate Army Medical Department (AMEDD) participation. Dr. John Crosley represents the Laboratory and Army aviation medicine to this group.

International test participating agreements

The ASCC is chartered to negotiate test participation agreements among the five English-speaking member nations and military services. These agreements provide for the evaluation, test, or review of a specific piece of equipment by another country or service not normally having access to that equipment. The evaluation data may be jointly gathered but, in any event, is shared between countries and published as a formal report in accordance with the terms of the agreement.

NAS-NRC committees on vision and hearing, bioacoustics, and biomechanics

USAARL has been an active participant in the science and technology exchange programs of the National Research Council (NRC) since the mid-1960s. USAARL scientists participate as working members to the various ad hoc and working groups of the acoustic and vision committees. The Army representative to the Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) and the Committee on Vision (COVIS) is USAARL scientist MAJ Bruce Leibrecht. Dr. James H. Patterson, Jr., Dr. Isaac Behar, Dr. John Crosley, Mr. Ben Mozo, and Dr. William Howse also participate actively.

NATO Defense Research Group Panel, Research Group 6 effects of impulse noise

Formed into a group in 1978, Canada, France, West Germany, the Netherlands, Norway, the United Kingdom, and the United States collect and evaluate data on permanent threshold shifts induced by shooting noise in military practice from both light and heavy weapons in relation to the noise exposure. The group evaluates methods of measurement of impulse noise and compares different impulse noise damage-risk criteria used by the participating nations. It evaluates the effects of noise-induced hearing loss on performance, collects and evaluates data on nonauditory effects, and exchanges information on the applicability of hearing protectors on the effects of hearing protection in military practice.

Dr. James H. Patterson, Jr., was appointed to membership in this working group in 1980.

Army Life Support Equipment Steering Council

This advisory council was chartered in the mid-1970s by the Commanding Generals of the US Army Aviation Systems Command (AAVSCOM) and US Army Training and Doctrine Command (TRADOC), the Office of The Army Surgeon General, and US Army Forces Command (FORSCOM). This is a review and advisory council that ensures timely and pertinent technical exchange of information regarding the development, logistics, use, and field problems associated with Aviation Life Support Equipment (ALSE). The committee meetings held yearly have proved to be an effective vehicle for maintaining a coordinated flow of technical information regarding life support equipment problems. USAARL participates as the principal technical consultant to the council and is instrumental in formulating AMEDD positions and policies.

The advisory council did not meet in 1984.

A formal meeting of this council is awaiting DA level guidance on the issue of the establishment of an Army life support equipment speciality. Secondly, the ALSE school established at Fort Eustis, Virginia, currently is writing a set of ALSE manuals incorporating specific tri-service life support equipment fitting, supply, and repair procedures. The future of the Army's ALSE efforts hinges on these two topics.

Tri-Service Aeromedical Research Panel

The Tri-Service Aeromedical Research Panel (TARP) was established in 1976 for the purpose of fostering technical exchange, reviewing ongoing joint research programs, making recommendations for future joint research programs, conducting cooperative reviews of individual programs to avoid duplication, and submitting a recommended course of action to The Surgeons General. The panel has proven to be an effective administrative entity in the DOD research community.

The TARP consists of 12 members which include two laboratory representatives from each service; a Surgeon General's representative from each service; one representative of the US Army Medical Research and Development Command; one representative of the Naval Medical Research and Development Command; and one representative of the Headquarters, Air Force Aerospace Medical Division, or Headquarters, Air Force Systems Command. The TARP meets in business session twice a year and hosts one extensive technical meeting.

COL Dudley R. Price serves as the Army's senior service representative and Deputy Co-chairman at TARP, and LTC J. D. LaMothe represents the Laboratory's interests.

The TARP has the authority to charter technical working groups (TWG) for the purpose of interacting at the scientific bench level and working on viable interservice cooperative research programs. At present, only one TWG exists--the one for Biodynamics: The human effects of vibration, impact, and acceleration. Under the auspices of this TWG, a joint service, Department of Transportation study to develop a standardized set of algorithms that describe the 50th percentile male aviator has been accomplished and a draft report was circulated to the TWG members.

Mr. Joseph L. Haley, Jr., and CPT Roy Maday are the Laboratory representatives for the TWG.

Tri-Service and NASA Human Factors Engineering Technical Advisory Group

Because of the diversity of the subject matter covered by the human factors engineering discipline, the scope of technical areas addressed by the Technical Advisory Group (TAG) is necessarily broad. In general, human factors engineering (HFE), as defined for the purposes of TAG operation, deals with concepts, data, methodologies, and procedures which are relevant to the development, operation, and maintenance of hardware and software systems. Subject matter subsumes all technologies aimed at understanding and defining the capabilities of human operators and maintainers and insuring the integration of the human component into the total systems to enhance systems effectiveness. Technologies directed toward improved manpower utilization through selection, classification, and training are included as appropriate.

TAG provides a mechanism for exchange of technical information in the development and application of HFE technology. This group enhances the coordination among government agencies and encourages in-depth technical interaction among subgroups in selected optical areas. TAG assists as required in the preparation and coordination of tri-service documents such as technology coordinating papers and topical reviews.

Army Aeromedical Concepts Review Committee (AACRC)

The Army Aeromedical Concepts Review Committee (AACRC) is a standing committee of the AMEDD for the purpose of collecting and disseminating information relative to aeromedical evacuation concepts, equipment, and techniques, and preparing coordinated AMEDD positions on Army aeromedical evacuation issues. The committee meets formally once a year with representation from the worldwide AMEDD aviation community, Army Reserve, National Guard Bureaus, DA Deputy Chief of Staff for Operation (DCSOPS), and other agencies as appropriate. USAARL, with a mission that includes aeromedical evacuation equipment development as well as general aviation medicine support that encompasses AMEDD aviation, has a long-standing history of intimate participation in the committee's activities.

Tri-Service Life Support Equipment Program

USAARL conducts a Tri-Service Life Support Equipment Retrieval Program (LSERP) which brings crash-damaged helmets, seats, and flight clothing to our facility for analysis and study. Helmets are the items most often received from the Air Force and Navy.

Army aviation life support equipment involved in either injury causation or prevention in the field is sent to USAARL for biomedical and injury correlation evaluation. The evaluation assesses the effectiveness or deficiencies of the life support equipment through an analysis of the physical condition of the protective devices, the human injury incurred, and the related human dynamics involved in the accident.

Data collected through the LSERP helps identify hazard protection problems associated with the equipment. Also, these data enable USAARL to provide injury-reducing design recommendations and health criteria for the improvement of life support equipment. The Navy Medical Department maintains a permanent position for a Navy aerospace physiologist at USAARL to support this program.

Advisory Group for Aerospace Research and Development--Aerospace Medical Panel

This panel was established in May 1952 and was an early pioneer in AGARD to discharge the mission of bringing together leading personalities of the NATO nations in the fields of science and technology relating to aerospace. The Aerospace Medical Panel (AMP) is concerned with the exchange of information on aerospace medical research and development, the recognition of operationally oriented requirements of clinical aerospace medicine, the solution of human engineering problems, and the stimulation of new research activities to assist and enhance pilot performance in the demanding aviation environment. The panel formally has chartered subcommittees concerned with the specific problems of behavioral sciences, biodynamics, special clinical and physiological problems in military aviation, and special senses.

USAARL has been an active participant with this panel since 1963. Members of the Laboratory serve on AMP subcommittees as technical consultants. COL Dudley R. Price is under appointment by the National Board of Delegates to AGARD/NATO as the US Army representative on this panel.

American National Standards Institute (ANSI) Committees S1, S3, and S12

These committees operate under the Acoustical Society of America by agreement with ANSI. They manage the development of a variety of National Acoustical Standards and coordinate international standardization in these areas. In 1983, USAARL became a member of these three committees. USSARL representatives are Dr. James Patterson, Jr., and Mr. Ben Mozo.

Committees

Committee	Affiliation	Individual
Aerospace Medical Association		
Scientific Program Committee	Member	COL D.R. Price
	Member	Dr. K.A. Kimball
American Burn Association		
Prevention Committee	Member	Dr. F.S. Knox III
Federal Laboratory Consortium	Member	Ms. S.H. Bullock
Air Standardization Coordinating Committee (International)		
Working Party 61 (Aerospace Medicine and Life Support Systems)	Army Representatives	MAJ B.C. Leibrecht
		LTC A.W. Schopper
American National Standards Institute		
S1 Acoustics	USAARL Representative	Dr. J. Patterson, Jr.
	Alternate	Mr. B.T. Mozo
S2 Mechanical Shock and Vibration	Alternate	Dr. J. Patterson, Jr.
S3 Bioacoustics	USAARL Representative	Dr. J. Patterson, Jr.
	Alternate	Mr. B.T. Mozo

Committee	Affiliation	Individual
S12 Noise	USAARL Representative	Mr. B.T. Mozo
	Alternate	Dr. J. Patterson, Jr.
Z90.1 Helmet Committee	Member	Mr. J.L. Haley, Jr.
53-62 Working Group on the Effects of Impulse Noise on Man	Member	Dr. J. Patterson, Jr.
Working Group on Real-Ear Attenuation Standards	Member	Dr. J. Patterson, Jr.
Department of Defense		
Aircrew Station Standardization Panel (Tri-Service)	Member	LTC A.W. Schopper
Joint Service Display Panel Subpanel on Display Devices	Member	Mr. C.E. Rash
Military Librarian's Workshop Program Committee	Member	Ms. S.H. Bullock
Group on Specification Problems and Standardization Actions on Audio Devices	Member	Mr. R.T. Camp, Jr.
Helicopter Research Coordinating Panel (Tri-Service)	Member	Dr. K.A. Kimball
Human Factors Engineering Technical Advisory Group (Tri-Service)	Member	Dr. K.A. Kimball
	Member	LTC A.W. Schopper
Tri-Service Aeromedical Research Panel (TARP)	Member	COL D.R. Price
	Member	LTC J.D. LaMothe
Tri-Service Aerospace Medical Coordination Technical Working Group	Member	Mr. J.L. Haley, Jr.

Committee	Affiliation	Individual
Department of the Army		
Advanced Attack Helicopter Alternate System Safety Group	Member	MAJ R.H. Schrimsher
Advanced Attack Helicopter Source Selection Evaluation Board	Member	Mr. C.E. Rash
	Member	Mr. B.T. Mozo
Aircraft Noise, Working Group (MIL-STD-8806)	Member	Mr. R.T. Camp, Jr.
Army Aviation Personnel Requirements for Sustained Operations, Study Advisory Group	Member	Dr. K.A. Kimball
Helicopter Medical Human Factors Engineering Trainin/Selection Research Coordination Panel	Member	Dr. K.A. Kimball
USAMRDC Vision and Laser Bioeffects Subcommittee	Member	LTC J.D. LaMothe
	Member	Dr. I. Behar
	Member	Mr. C.E. Rash
Source Selection Board on Ocular Protection Against Laser Hazards	Member	Mr. C.E. Rash
USAMRDC Neuroscience Working Group for Chemical Defense	Member	Dr. A.W. Kirby
	Member	CPT T.H. Harding
TSG Ad Hoc Committee on Hearing Protective Devices	Member	MAJ W.R. Nelson
	Member	Mr. R.T. Camp, Jr.
	Member	Dr. J. Patterson, Jr.
		Mr. B.T. Mozo

Committee	Affiliation	Individual
US Air Force		
Test Plan Working Group: Second Generation Chemical Warfare Defense Personnel Protective Garment Program	Member	MAJ G.A. Nagel
Federal Aviation Administration		
Seat Committee	Member	Mr. J.L. Haley, Jr.
National Academy of Sciences--National Research Council		
Committee on Vision	Army Representative	MAJ B.C. Leibrecht
	Member	Dr. J.K. Crosley
	Member	Dr. I. Behar
Committee on Hearing, Bioacoustics, and Biomechanics (CHABA)	Army Representative	MAJ B.C. Leibrecht
	Member	Dr. J. Patterson, Jr.
	Member	Mr. R.T. Camp, Jr.
	Member	Dr. W.R. Howse
North Atlantic Treaty Organization--Advisory Group for Aerospace Research and Development		
Aerospace Medical Panel	Army Representative	COL D.R. Price
Behavioral Sciences Committee, AMP	Member	Dr. K.A. Kimball

Committee	Affiliation	Individual
Evaulation of Methods to Assess Workload, AMP Working Group 08	Member	Dr. K.A. Kimball
Research Study Group 6, Effects of Impulse Noise	Member	Dr. J. Patterson, Jr.
US Army Aviation Center		
NBC Steering Committee	Member	Dr. F.S. Knox, III
Army Aviation Threat Committee	Member	Dr. K.A. Kimball
Army Aviation Mission Area Analysis	Member	Dr. K.A. Kimball
Fort Rucker Flight Standardization Committee	Member	MAJ R.A. Huether

Technology transfer

Provisions of the Stevenson-Wydler Technology Act of 1980 (PL 96-480) continued to be implemented during FY 84. Representatives were sent to Federal Laboratory Consortium (FLC) Meetings and to meetings called by Department of the Army held in Washington, DC. USAARL's Office of Research, Technology, and Assessment (ORTA) representative functions as Deputy Director Southeastern Region, Federal Laboratory Consortium.

More than 100 requests were received by the Scientific Information Center for either information or copies of bibliographies or technical reports.

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